Germany now uses silver increasingly for many industrial purposes, the Consulate at Frankfort-am-Main reports. Hard-solder alloys containing it serve in electrical apparatus, in mechanical installations for processing foodstuffs and chemicals, and in oil conduits for airplanes and motor vehicles. The metal's high corrosion resistance is useful in distillation apparatus in the chemical industry, and silver jackets have proved highly resistant to sulphuric and other acids. Silver is also being used increasingly for coating cans for foodstuffs, and in alloys for lining bushings and bearings for airplanes.

▼

Texas led the States in 1937 in value of mineral output, the Bureau of Mines reporting its production at more than $813,000,000. Pennsylvania followed with almost $600,000,000, then California, with approximately $477,000,000, and West Virginia, with $307,000,000. Next in line were eight States with outputs ranging from $182,000,000 down to $106,000,000, these being Louisiana, Kansas, Minnesota, Illinois, Ohio, Kentucky, Michigan, and Utah, in order of output. Petroleum and coal exercise a powerful influence in the race for leadership.

▼

Shortite is the name bestowed on a new mineral found and identified by J. J. Fahey, chemist of the United States Geological Survey. It is a double carbonate of sodium and calcium and was noted as well-formed crystals in sections of the core of an oil well drilled in Wyoming. It was named in honor of Dr. G. M. Short, former geologist of the Survey.

▼

Russia's desire to "change things" includes the renaming of towns some of which are at or near metal-mining districts. Kalata, in the Urals, is now Kirovgrad; Karabash is Kyshtym; Petropavlovsk, in the Far East, is Kyzyl Dzhar; Samara is Kuibyshev; Golodnaya Steppe (Hunger Step), near copper deposits, is now Mirza Chul; and Chiaturi, of manganese fame, is Chiatura; Manchuli becomes Manchuriya; and Tiflis is Tbilisi.

H. C. PARMELEE
Editorial Director

Engineering and Mining Journal

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Vice-President

Published by McGraw-Hill Publishing Co., Inc.
New York, San Francisco, London

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Copyright 1939 McGraw-Hill Publishing Company, Inc.
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Published monthly. Subscription rates: United States and Canada, $3 per annum; other countries in the Americas outside the United States and Canada, $4 per annum; elsewhere $5 or 30 shillings per annum. Price per copy 50c. or 3s. Entered as Second Class Matter September 18, 1936, at Post Office, Albany, N. Y., under Act of March 3, 1879. Printed in U. S. A.
Cable Address: New York McGraw-Hill, N. Y.

McGRAW-HILL PUBLISHING COMPANY, Inc.
JAMES H. McGRAW
Founder and Honorary Chairman
Publication Office, 99-129 N. Broadway, Albany, N. Y.

McGRAW-HILL PUBLISHING COMPANY, LTD.
Cable Address: Backlash, Estrand, London
Aldwych House, Aldwych, London, W. C. 2, England

Editorial and Business Offices: 330 W. 42d Street, New York City, N. Y.
San Francisco, 68 Post Street; Chicago, 520 N. Michigan Avenue; Washington, D. C., National Press Building

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Volume 140 Number 10

OCTOBER, 1939

Outlook for Mining

INEVITABLY the war in Europe must affect American mining industry, even in the face of widespread determination, to which we ourselves adhere, to keep the United States out of the conflict. No nation lives wholly to itself in these times. The United States is no exception, and its metal-mining industry must feel the impact of world-wide conditions. What, then, is the outlook for the domestic non-ferrous metal business? We offer a few observations.

In the first place, conditions in 1939 are so vastly different from those of 1914 as to make impossible any appraisal of today's outlook in terms of 1914. One common factor will be rising costs in the form of higher taxes, wages, and prices. But aside from that the old guideposts are useless.

The cost of producing an ounce of gold will probably rise as it did in 1915, resulting in the abandonment of some marginal producers, selective mining on the part of others, and reclassification of ore reserves. With the price of the metal fixed by the Government, higher costs must be absorbed by the producer, or offset, if possible, by improved technology. Silver production may be expected to increase as the outputs of copper and lead gradually rise. The higher price for silver established in July will work to the advantage of producers.

It is in the copper, lead, and zinc industries, however, that the most drastic changes have occurred in the past 25 years. The United States now plays a lesser rôle in world production of these three metals than it did in 1914–18. In 1914 the United States was turning out 57 per cent of the world's copper; in 1938 only 26 per cent. In zinc, domestic production was 55 per cent of the world's output in 1914–18, and only 26 per cent in 1938. Likewise with lead, of which the United States produced 50 per cent of the world's supply in 1914, and only 25 per cent in 1938. These striking changes have resulted from discovery and development of new mineral resources in Rhodesia, Canada, South America, and Australia, the ultimate effect of which has been practically to divorce the United States from the world market for these metals and restrict domestic production to home demand.

The domestic market for these metals in the near future promises to be a good one, and mining companies may look forward to satisfactory profits and good prices for their products. Production and prices may trend mildly upward, but one should not expect a runaway speculative market, remembering that the Administration at Washington frowns on high prices, large profits, wild speculation, and runaway markets. Furthermore, it has many controls over these matters that it can throw into high gear on short notice. The National Defense Act of 1916 is still on the statute books and can be invoked to regulate prices and production.

These observations are predicated on current business conditions in this country and take no account of modification of the neutrality law. If and when the latter is modified, England and France may find it necessary to supplement their metal fabricating facilities by purchasing finished metal goods in the United States. This would almost certainly be the case if their present facilities were seriously damaged or destroyed by bombardment. Cessation or prolongation of the European war would also affect the prospect. But leaving these uncertainties out of account, the near outlook for domestic mining is good.

Belated Action on Mineral Stockpiles

TOO LATE BY SEVERAL YEARS, the Government has now begun the process of accumulating stockpiles of strategic metals and minerals, and of investigating the occurrence and extent of domestic ores and minerals necessary to national defense. Specifications

are being prepared and published for the information of prospective bidders. Details on manganese, chromium, and tungsten ores have already been issued and will be found in our Washington news section. All such Federal specifications will be published there as issued by the Procurement Division of the Treasury Department.

A fancy price will be paid for delay in initiating a policy so long and wisely advocated. Tungsten ore, which could have been bought in 1936 for $16 per unit WO_3, now sells at $25. Tin, selling at 46¢. per pound, New York, in 1936, has sold recently as high as 68¢. So unsettled are the markets for manganese and chromium ores, that price quotations are nominal. Quicksilver, averaging $75 per flask of 76 lb. in 1938, now has a wholly nominal price of $150. The examples typify the conditions that will confront the Government in acquiring strategic materials.

Considering our experience during the World War, we should have been better prepared for the present emergency. The international scramble for minerals at that time is a matter of common knowledge, and it was to avoid a repetition of those conditions that a mineral policy was advocated by the Bureau of Mines, the Planning Committee for Mineral Policy, the National Resources Board, the Mining and Metallurgical Society of America, the American Mining Congress, and other agencies. The Government has not lacked competent advice, but it has been pitifully slow in executing a policy of such obvious wisdom and national importance.

Open Season for Highgraders

WHEN THE LAW IS LENIENT with a confessed thief of gold amalgam, what recourse has a mining company to insure the enjoyment of its property? Such is the predicament confronting the owners and operators of the Washington mine and mill near French Gulch, Shasta County, California. After obtaining from one of their mill operators a confession and plea of guilt to repeated thefts of amalgam, the plaintiffs had the discouraging experience of hearing the local Justice of the Peace place the defendant on probation and release him from custody. On its face the record of the case reveals an amazing and discouraging miscarriage of justice. Highgrading is a vicious practice of serious import to gold mines and mills. Operators make every effort to prevent it, but crafty employees still succeed in eluding the safeguards. The last and often unwilling resort of the victim is to detect and convict the thief. If the courts then look complacently on the practice, it is time to elect some new representatives of justice.

Honoring Veteran Employees

MEN GIVE THEIR LIVES to industry. Almost every organization that has existed for a quarter of a century or more numbers among its employees men who have helped to make the institution what it is today. Others may come and go, but these remain to give stability and continuity to their company. They are deserving of recognition. And they are receiving it, thanks to a growing appreciation of public relations as a factor in a company's business. Typical is the recent action of Allis-Chalmers Manufacturing Company in honoring thirty-eight fifty-year men. As guests of the company and its Foreman's Club at a dinner and entertainment, each man received a gold watch and a copy of a golden anniversary brochure bearing the happy title "We've Gone Places Together." The booklet is dedicated by the officers of the company to the fifty-year men, each of whom is featured by a portrait and brief biographical sketch. Thus is that modern but fallacious bugaboo, "aged 40," effectively laid at rest.

Keeping Employees Informed

EQUALLY SIGNIFICANT in the field of public relations is the recent talk by Clinton H. Crane, president, St. Joseph Lead Company, to employees at Bonne Terre, Missouri. Feeling that they should "understand the present situation in lead, at least as well as I understand it myself," Mr. Crane reviewed current economic conditions in contrast to those prevailing in 1914. Citing the foreign sources of metal that have come into production since then, he showed that the proportion of domestic to world production of lead had dropped from 50 per cent in 1914 to 25 per cent in 1938. He discussed current markets and prices, at home and abroad, explained the company's policies in production and marketing, made it clear that there is plenty of lead for domestic business, emphasized the greater importance of lead in peace than in war, and expressed the hope that present conditions of employment and production could be maintained for a time. A "family party" of this character must be a source of satisfaction to every man in the organization, and bring stability through confidence and understanding.

Pumping Against 3304-Ft. Head In a Single Lift

Magma Copper's mine water first passes through condenser of underground air-conditioning system

E. E. Slack
Mechanical Engineer, Magma Copper Company, Superior, Ariz.

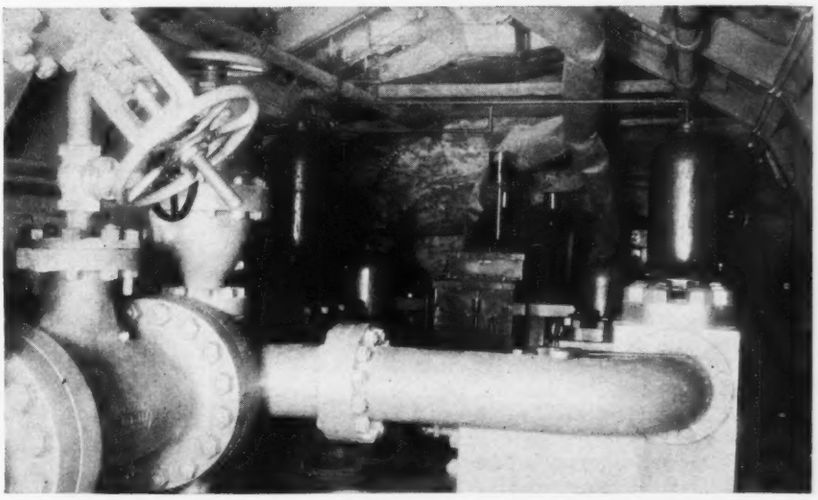
PUMPING at the Magma mine of Magma Copper Company, at Superior, Ariz., was not particularly difficult at shallow depths or up to the time that refrigeration was added to the mine, but that innovation changed pumping conditions materially. In July, 1937, the company started an air-conditioning plant on the 3,600 level. This was installed to condition the air on the 3,400 and 3,600 levels, where unusually high rock temperatures were encountered. All underground water, varying in quantity from 350 to 500 g.p.m., is used by the plant for condenser water, entering the condenser at about 90 deg. F. and leaving at 110 to 113 deg. F. When the air-conditioning plant was first started, the return condenser water was removed from the mine by the old pumping system then in use.

The installation consisted of three lifts, these being from the 3,600 to the 2,550 level, from the 2,550 to the 1,600 level, and from the 1,600 to the 500 level respectively. On the 500 level the water was discharged into an open ditch and flowed out of the mine through a 1,500-ft. adit into large wooden tanks, from which it was distributed to the mill, smelter, and other places.

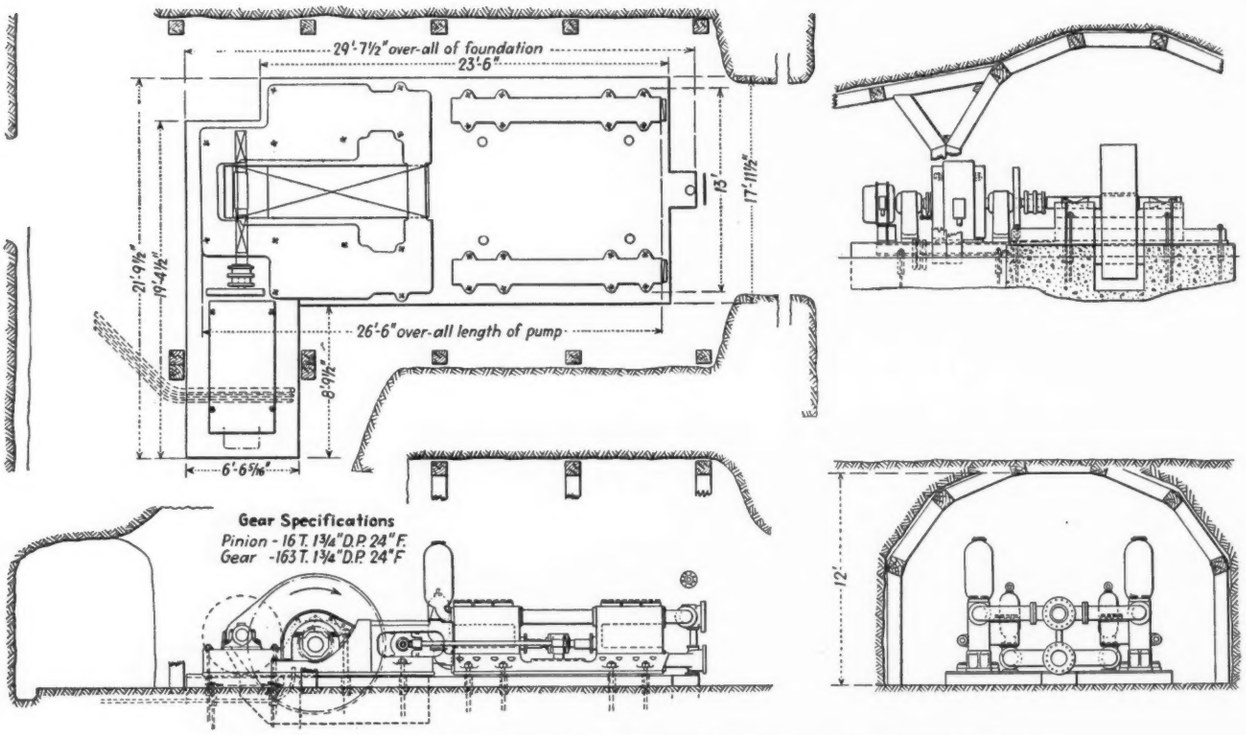
For practically their entire length these pump columns and the open ditch were in a fresh-air intake of the mine, and considerable heat was transmitted by radiation and convection from them to the incoming air, thus nullifying to some extent the benefits obtained by air conditioning. For example, the condenser water, which left the conditioning plant at 113 deg. F., had been cooled to 105 deg. F. by the time it was discharged into the open ditch, and finally cooled to 100 deg. F. on reaching the surface through the 1,500 ft. of adit. The pump lines, in thus radiating heat in the downcast shaft, had the effect of forming a column of hot air, making it necessary to have additional power for the fans that had to pull the hot air down into the mine. The open ditch, on the 500 level, raised the temperature and humidity of the air with which it can in contact, as previously intimated.

Under these conditions, it was estimated that a new pumping system could be paid for in a short time if the pumps could be placed nearer the air-conditioning plant and the water could be pumped out of the mine in one lift through an upcast ventilating shaft. Accordingly, plans were made to install new pumps near the No. 8 shaft, which is the main exhaust ventilating shaft for the west section of the mine, and to pump the water in one lift. The column of hot air formed by radiation from the pipes handling the hot water thus would help instead of impede ventilation. After the new system had been placed in operation, it was found that the incoming air along the old route was 9 deg. cooler on the wet-bulb thermometer, and that the relative humidity of the air had decreased 14 per cent.

The new plant consists of two main pumps running singly, alternating in operation. Pumping time requires from 16 to 20 hours, depending upon wet and dry seasonal periods. The operating crew consists of one man per 8-hour shift, replacing nine men required on the former three-lift system. A description of the pumping equipment follows: There are two Prescott-Menominee 6¼x24-in., center-packed duplex, double-acting, horizon pumps



Operating on the 3,600-ft. level near the upcast side of the mine ventilation system, the temperature in the pump room is usually above 90 deg. F. and around 80 per cent humidity



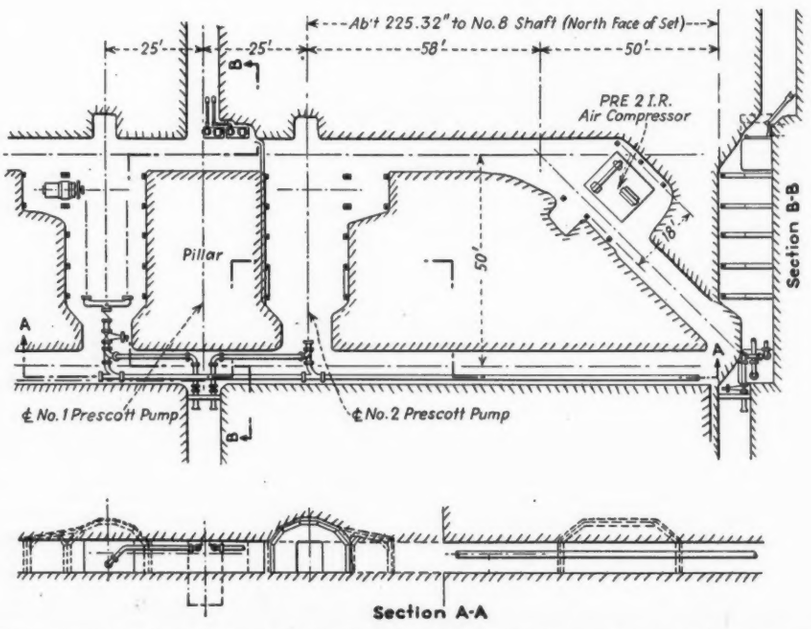
Foundations of the new high-lift pumps in the Magma mine, in plan, elevation, and sections

of 600-g.p.m. capacity each, built for 3,465-ft. (1,500 lb.) total head. Each is direct-connected to a 600-hp. Allis-Chalmers, a.c., 2,200-volt, 3-phase, 25-cycle, 485-r.p.m. motor fitted with flywheel and flexible coupling, through one 21-to-209 herringbone-gear reduction driving the pump at 48.5 r.p.m., which is equivalent to 194-f.p.m. piston speed.

The pumps are situated between No. 14 winze and No. 8 shaft in separate chambers and are surrounded by drifts, with sumps between the pumps. Being on the upcast side of the mine ventilation system, the temperature runs around 93 deg. F. and 80 per cent humidity, making a severe operating condition. The major part of the cold mine water comes from the bottom of No. 6 shaft on the 2,550 level, whence it is carried in an open ditch and then in a pipe line through a winze to a sump at No. 3 shaft on the 3,200 level. It is then piped down No. 3 shaft from the 3,200 level to the 3,600 level, and again carried in an open ditch to the sublevel drainage sump just below the 3,600 level. The total distance is about 10,000 ft.

From the drainage sump the water is picked up by small centrifugal pumps and delivered to the refrigerating condensers and into a sump, from which it is pumped back to the elevated sump between the main pumps, to which the main pump suctions are attached. Current total pumping head is 3,304 ft. The pumps discharge through a bypass tee to eliminate excessive starting load on the motor, thence through a check valve and gate valve into about 285 ft. of 10-in., 80.1-lb. pipe running horizontally in the crosscut to the shaft. This horizontal line is supported by concrete piers with slide plates to allow the line to expand. The line then joins the shaft column, where the water starts its long, vertical ascent to the surface —a distance of 3,210 ft., and to our knowledge the highest lift of any underground or mine plant in operation.

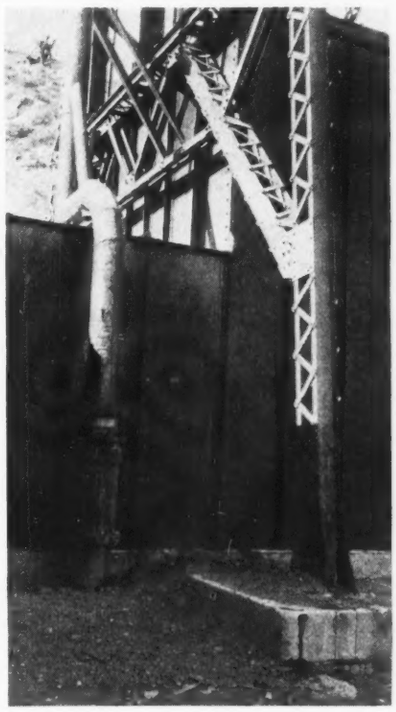
The entire shaft pipe column is supported on two 30-in., 108-lb. I-beams set in concrete across one corner of the shaft. Total load is about



Pump station on the 3,600 level in the Magma mine. The location of the two high-lift pumps is shown

118 tons. The column is painted with a heavy pipe enamel. The shaft in which it is installed has four 5x5-ft. compartments and is timbered with steel shaft sets placed 5 ft. center to center. To hold the column plumb and at the same time permit it to slide, inasmuch as considerable expansion develops near the top because of temperature changes of the air in the shaft and the water in the pipe, the pipe column is guided at frequent intervals.

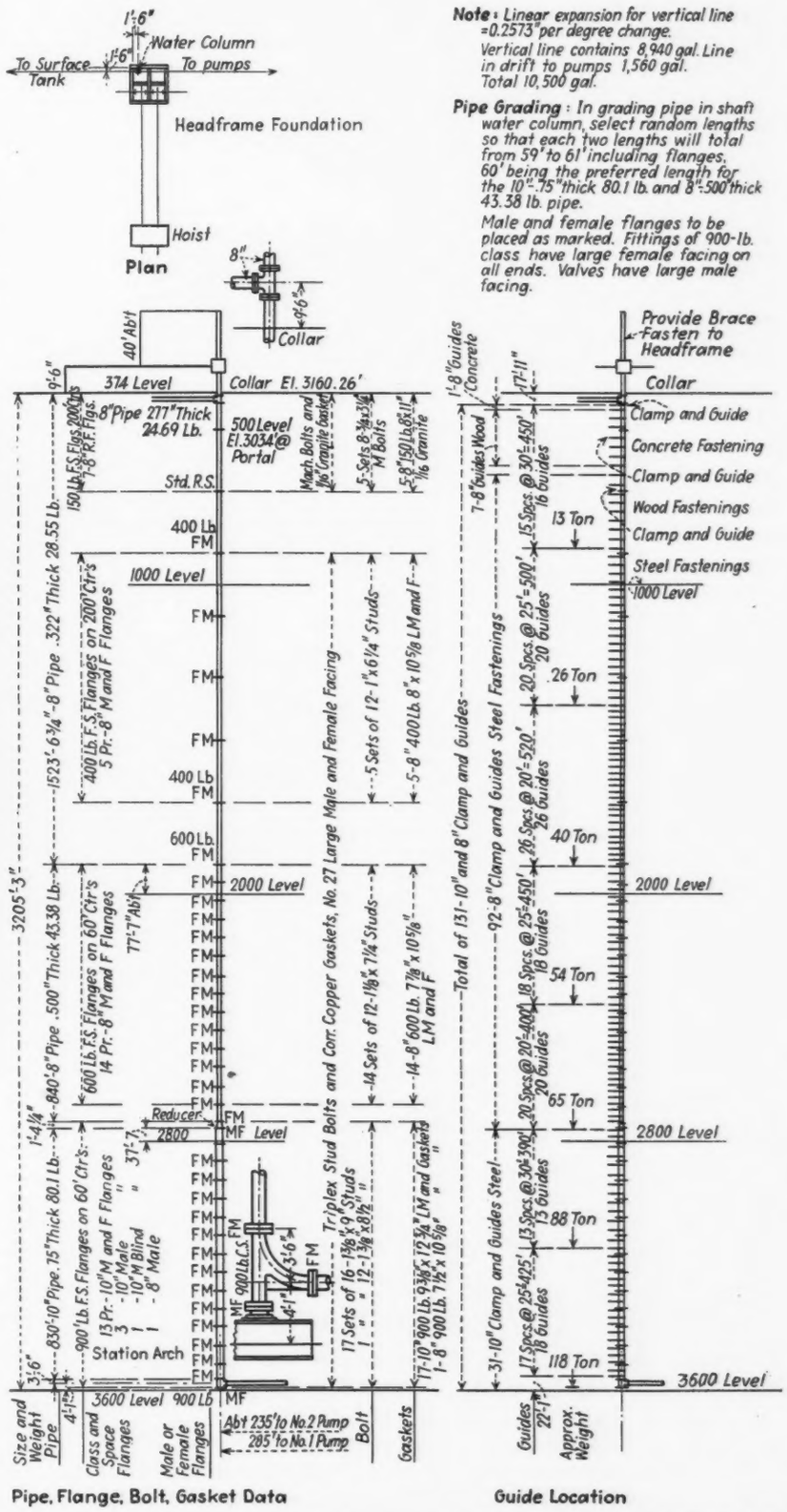
At the surface over the shaft is a 200,000-c.f.m. Jeffrey double-inlet fan. The pipe column and standpipe running through the roof of the intake duct are high enough to provide head for the water to flow to a large wooden tank, from which it is distributed as required. An expansion joint on the down leg takes care of any expansion and breathing of the pipe



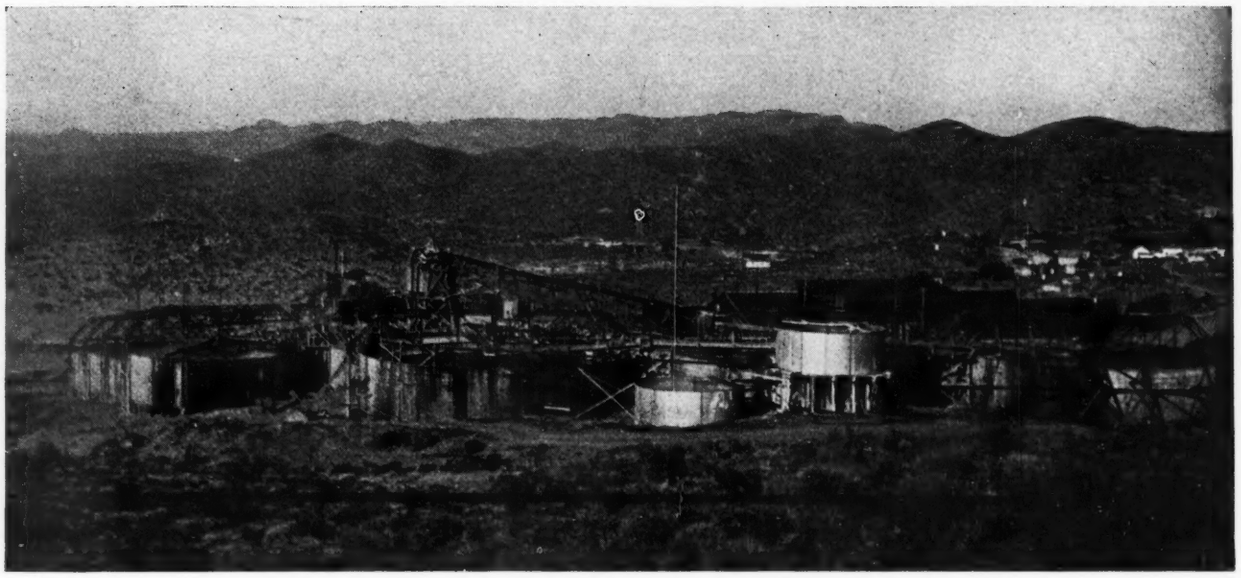
Discharge pipe 8 in. in diameter at surface

line. Both pump and pipe column are well air-cushioned, the pulsations being hardly noticeable either at the pump or up at the surface. The pipe column is given periodic inspections and, so far, no trouble has been encountered. Installation of the complete pumping system involved an expenditure of $120,000.

To put the pipe column in place was a most difficult matter, as the heavy pipe had to be handled with a small sinker hoist and under a 65-ft. headframe. The entire line is welded, and consists of class "B" pipe, including C. S. welding neck flanges. It was received in 30-ft lengths, one weld being made in a jig on the surface. Each section between flanges was given a hydrostatic test before being lowered and bolted in place. The entire column was found tight upon completion at the final test. Credit is given to the company's mechanical department for the installation of the pipe column and pumping equipment.


Note: Linear expansion for vertical line =0.2573" per degree change.
Vertical line contains 8,940 gal. Line in drift to pumps 1,560 gal.
Total 10,500 gal.
Pipe Grading: In grading pipe in shaft water column, select random lengths so that each two lengths will total from 59' to 61' including flanges. 60' being the preferred length for the 10"-.75" thick 80.1 lb. and 8"-.500" thick 43.38 lb. pipe.
Male and female flanges to be placed as marked. Fittings of 900-lb. class have large female facing on all ends. Valves have large male facing.
Water Column
To Surface Tank
To pumps
Headframe Foundation
Hoist
Plan
Collar
Collar El. 3160.26'
374 Level
500 Level El. 3034' @ Portal
Std. R.S.
1000 Level
2000 Level
2800 Level
3600 Level
Reducer
Station Arch
Provide Brace Fasten to Headframe
Clamp and Guide
Concrete Fastening
Wood Fastenings
Steel Fastenings
13 Ton
26 Ton
40 Ton
54 Ton
65 Ton
88 Ton
118 Ton
Pipe, Flange, Bolt, Gasket Data
Guide Location

Water column data and guide location for the new high-lift pumping system in No. 8 shaft, Magma mine



Cyanide plant treats around 1,400 tons of tailings daily

Yellow Aster Yields a Profit On Large-Scale Operations

Present operator mines 3000 tons of low grade ore per day, rejects 2000 after crushing and screening, and treats the remainder by amalgamation. Tailings, current and old, are cyanided

John B. Huttl
Assistant Editor

THE largest gold-mining enterprise in the West (Alaska excluded) from a standpoint of tonnage handled, and one at which material carrying less than $1 in gold is treated profitably, is the Yellow Aster property, at Randsburg, Kern County, Calif., operated by the Anglo American Mining Corporation, of San Francisco. Randsburg, the largest settlement in the district, is situated in a small valley in the northeast end of Rand Mountains, about 75 miles east of Bakersfield and 100 miles northeast of Los Angeles, at an elevation of 3,523 ft. The mine, crushing plant, and mill are about half a mile south of the town and at several hundred feet higher elevation; and the cyanide plant erected by the company in 1935 is on a gently sloping site a short distance below the old tailing dumps. Climatic conditions, accessibility over excellent highways, and proximity of large centers such as Bakersfield, Los Angeles, and San Bernardino favor operations. A branch line of the Southern Pacific Railroad from Mojave passing 5 miles to the northwest serves the district. Electric power is obtained at a reasonable rate from the Southern Sierras Power Company, and water is pumped to the property from a point 7 miles distant.

The Yellow Aster mine is a relatively old enterprise, having been discovered in 1895 by three prospectors named C. A. Burcham, John Singleton, and F. M. Mooers. Early operations consisted of crushing high-grade ore in hand mortars and reducing the amalgam in small retorts holding about $150 in gold. Milling operations commenced in 1899 after completion of a 30-stamp mill. Two years later a 100-stamp unit was added, and exploitation continued steadily until 1918. During this period the mine produced $8,424,577 in gold from about 4,000,000 tons of ore mined, of which 2,800,000 tons were milled and the remainder discarded as waste, with a dividend disbursement of $1,205,789. After 1918 the mine was worked spasmodically by leasers, and it was not until the latter part of 1933 that the present operators took over the property.

Current work involves mining some 3,000 tons of low-grade ore a day, followed by crushing and screening to raise grade, with the final product, amounting to about 1,000 tons, being treated in the milling department by amalgamation methods. Mill tailing and tailings from previous operations hydraulicked from dumps originally containing nearly 2,600,000 tons and averaging $1.14 in gold are jointly treated in the cyanide plant mentioned previously. Hydraulicking and milling are done in and with barren cyanide solution.

The main orebody now under exploitation is a triangular mass of low-grade ore consisting chiefly of mineralized monzonite. Its boundaries are more or less defined by three faults—namely, on the east by what is locally known as the Hercules fault, on the north by the Jupiter, and on the southwest by the Security or footwall fault.

All ore is oxidized and free milling. The monzonite is porous and badly stained as a result of the action of primary mineralizing solution and oxidation, and is filled with a network of quartz veinlets. Both the quartz veinlets and the adjacent monzonite contain gold. In the glory hole which is the major working at the mine, the ore is removed by open-pit methods, and the broken material is loaded into 10-ton trucks for trans-

portation to the crushing plant by a 2½-yd. Northwest power shovel. This work is done under contract by the Macco Construction Company, of Clearwater, Calif. Though the material still remaining in the glory hole is believed to be between five and six million tons, the exact figure will not be known until the southerly limits of the ore have been determined.

At the time of my visit early in April all mining in the glory hole was suspended, pending completion of some bench work along the upper rim of the pit. Mill feed is being obtained currently from large dumps adjacent to the glory hole, the material being removed by the equipment used in open-pit operations. The dumps originally contained some 1,300,000 tons of ore averaging 85c. gold per ton. Haulage distance from the glory hole and dumps to the bin at the crushing plant is about a quarter of a mile. At the crushing plant the grade of the material is raised by screening out the coarse particles to give a mill feed assaying between $2 and $2.50.

The treatment the ore undergoes at the crushing plant and mill is graphically explained in flowsheet 1. Reduction of the ore to minus ¼ in. is accomplished by two-stage crushing with intermediate and subsequent screening. Equipment available for this work includes a 60x48-in. Allis-Chalmers jaw crusher producing a 5-in. product; a 4-ft. Traylor type TY gyratory crusher, set to 1¼ in.; Tyler Niagara double-deck primary vibrating screen using screens with 3x3-in. and 1x1-in. openings; and two Tyler Niagara double-deck secondary screens with ¼x½-in. openings. Plus 3-in. oversize from the primary screen and oversize from the secondary screens go to the waste dump. The secondary screen product is transported to the 1,800-ton fine-ore bin at the head of the milling department.

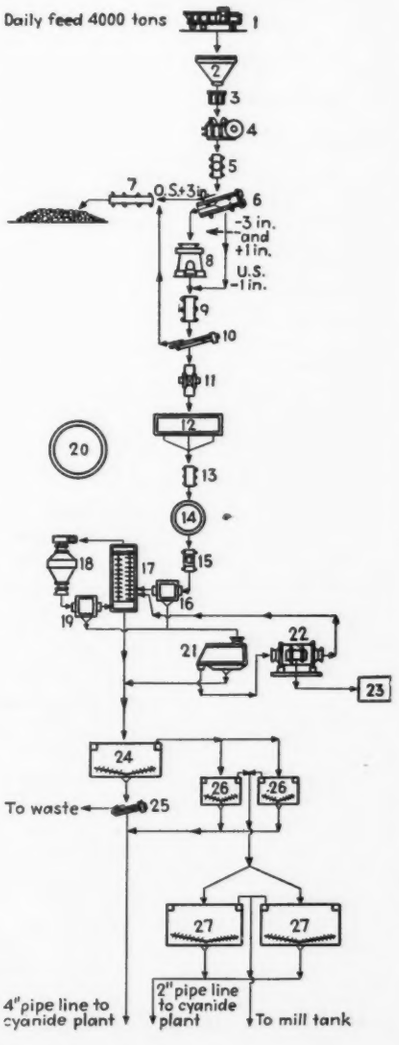
All materials are handled by belt conveyors, a 30-in. unit serving the primary screen, a 24-in. unit the secondary screens and waste disposal, and an 18-in. unit delivering into the fine-ore bin. The 30-in. and the 18-in. conveyor belts are respectively equipped with a Dings magnetic pulley and an automatic tripper. The Sheridan grizzly feeder on the coarse-ore bin is powered by a variable-speed motor, and feed operations are controlled by an operator from a nearby room. Light signals and several horns indicate immediately any motor failure on the different machines, and as a consequence permit the operator to cut the feed without delay.

From the fine-ore bin the ore is withdrawn through gate feeders and delivered to a 40-ton surge bin via a 16-in. belt conveyor. Next it goes over an incline 16-in. conveyor to a 42x42-in. Pan-American jig and then to a Dorr rake classifier operating in open circuit with an 8-ft. by 36-in. Hardinge ball mill grinding to about minus 3 mesh. A second 42x42-in. Pan-American jig operates below the ball-mill discharge. The hutch product of both jigs is sent to a Wilfley table, the concentrate being treated in a large, continuous amalgamating barrel, and the tailings joining the classifier overflow directed to the dewatering plant. Material discharge from the amalgamating barrel returns to the classifier; the amalgam is sent to the clean-up room for reduction.

LEGEND

1. 9- to 10-ton trucks
2. 170-ton coarse-ore bin
3. Sheridan grizzly feeder
4. 60x48-in. Allis-Chalmers jaw crusher
5. 30-in. belt conveyor with Dings magnetic pulley
6. Double-deck Tyler Niagara vibrating screen
7. 24-in. waste conveyor
8. Traylor Type TY4 gyratory crusher
9. 24-in. belt conveyor
10. Two double-deck Tyler Niagara vibrating screens
11. 18-in. belt conveyor with automatic tripper
12. 1,800-ton fine-ore bin with gate feeders
13. 16-in. belt conveyor
14. 40-ton surge bin
15. 16-in. incline belt conveyor with Constant-weight feeder
16. 42x42-in. Pan-American jig
17. Dorr rake classifier
18. 8-ft. by 36-in. Hardinge ball mill
19. 42x42-in. Pan-American jig
20. Mill tank
21. Wilfley table
22. Amalgamating barrel
23. Clean-up room
24. 30-ft. thickener
25. Link-Belt vibrating screen
26. Two 18-ft. thickeners
27. Two 40-ft. thickeners

Fig. 1 . . . The flowsheet of the Yellow Aster crushing plant and mill, showing the treatment by amalgamation after the coarse material has been rejected



At the dewatering plant the classifier overflow or cyanide plant feed is treated in a series of thickeners to recover the largest possible volume of solution to reduce subsequent pumping at the cyanide plant to a minimum, and settle out a portion of what is locally termed "colloidal" slime used at the sand-leaching plant for sluicing out tanks. Particles coarser than 6 mesh are removed from the final cyanide plant feed by a Link-Belt vibrating screen covered with a 6-mesh screen. As will be seen, the classifier overflow, jig tailings, and Wilfley table tailings first go to a 30-ft. thickener, from which the overflow is passed to two 18-ft. thickeners, and the underflow goes over the vibrating screen mentioned previously. Oversize from the screen goes to waste, and the undersize flows by gravity through a 4-in. steel pipe to the cyanide plant. This pipe also handles the underflow from the 18-ft. thickeners. The overflow from these units receives additional treatment in two 40-ft. thickeners, from which the overflow is pumped to the mill tank, and the underflow directed via a 2-in. steel pipe to the 100-ft. centre-pier Dorr thickener at the cyanide plant.

At the time of my visit, the cyanide plant was treating about 1,000 tons of mill tailings and 350 tons of stored tailings daily. The latter material is removed and sluiced into a common sump by hydraulic methods, with one man per shift employed. Transfer from the sump to the surge tank at the cyanide plant is done by a 6-in. Wilfley pump attached to a steel pipe line fitted with special joints at short intervals to facilitate rapid assembly and cleaning of clogged sections in case of pump failure. Because of the steep slope of the ground on which the tailings rest and the character of the material itself, solution and water consumption is relatively low. Operation and layout of the cyanide plant, and flow of pulp and solutions, are shown in flowsheet 2. From the 12x6-ft. surge bin the pulp passes to two 6x22-ft. Dorr rake classifiers for separation of sands and slimes. The sands go direct to the leaching plant consisting of eight 45x12-ft. redwood tanks, each charged by means of a slow-moving pierced launder, and capable of holding a day's charge of some 660 tons.

Plant equipment and auxiliaries permit the eight-day operating cycle

A 2½-cu.yd. shovel and 10-ton trucks remove ore from dumps near glory hole

explained in detail in the flowsheet. Solution drained from the six tanks leaching is treated successively in a clarifier tank and Merrill-Crowe precipitation plant, the resultant precipitates being reduced to bullion in the refinery. Barren solution is pumped to the first agitator, secondary thickeners, and 100-ft. centre-pier thickener. Leached sands are sluiced from each tank with water and some barren solution after addition of a predetermined amount of colloidal slime. This material is obtained both from the continuous filters and the secondary thickeners (underflow). Final tailings are directed to the dumps, where facilities are available to reclaim some of the contained solution, which is pumped back to the mill tank.

The slimes from the two classifiers handling the plant feed pass by gravity to a 60x12-ft. hydroseparator, with the overflow at 8 to 10 per cent solids going to the 100-ft. centre-pier thickener, and the underflow at 35 per cent solids flowing to the two 60x12-ft. primary thickeners. Overflow from these units is pumped to the sand-leaching plant for leaching tanks charged most recently, and the underflow is sent to three 16x14-ft. agitators. The primary thickener underflow contains about 52 per cent solids, which figure is reduced to 45 per cent in the first agitator by addition of barren solution. At this point also are added cyanide and lime. The pulp is retained in the agitators for a period ranging from four to six hours. Two 60x10-ft. thickeners receive the product discharged from the last agitator. Part of the underflow (50 per cent solids) is pumped to the sand-leaching plant for sluicing out leached sands from tanks, or sent to the Oliver filters, and the overflow is returned to the mill tank. Overflow from the 100-ft. centre-pier thickener is pumped to the solution storage tank, from which about 600 tons are sent to the pregnant-solution tank preceding the clarifiers, and some joins the classifier sands flowing to the leaching plant. The underflow is treated in three 14x14-ft. Oliver filters with two repulpers, the filtrate going to the solution storage tank, and the repulp being pumped to the sand-leaching plant for sluicing tanks, or sent direct to the residue pump.

Consumption of chemicals, power, and water per ton of ore treated is as follows: Cyanide, 0.25 lb. 90 per cent pure NaCN; lime, 3.5 lb.; zinc dust, 0.10 lb.; power, 7 kw.-hr.; and water, 1.12 tons.

Executive officers of the company are Walter Lyman Brown, president, and H. W. Klipstein, executive vice-president, to whom thanks are due for permission to publish the foregoing account, and to A. W. Frolli, general manager, and Glenn L. Allen, mill superintendent, I am indebted for the information and data contained therein.

LEGEND

1. 45x12-ft. sand tank
2. 45x12-ft. sand tank
3. 45x12-ft. sand tank
4. 45x12-ft. sand tank
5. 45x12-ft. sand tank
6. 45x12-ft. sand tank
7. 45x12-ft. sand tank
8. 45x12-ft. sand tank
9. 12x6-ft. surge tank
10. Two 6x22-ft. Dorr classifiers
11. 60x12-ft. Hydroseparator
12. Two 60x12-ft. primary thickeners
13. Three 16x14-ft. agitators
14. Two 60x10-ft. secondary thickeners
15. 100-ft. centre-pier thickener
16. Three 14x14-ft. Oliver filters
17. Pregnant-solution storage tank
18. Clarifiers
19. Merrill-Crowe precipitation plant
20. Refinery
21. Mill tank
22. Solution storage tank

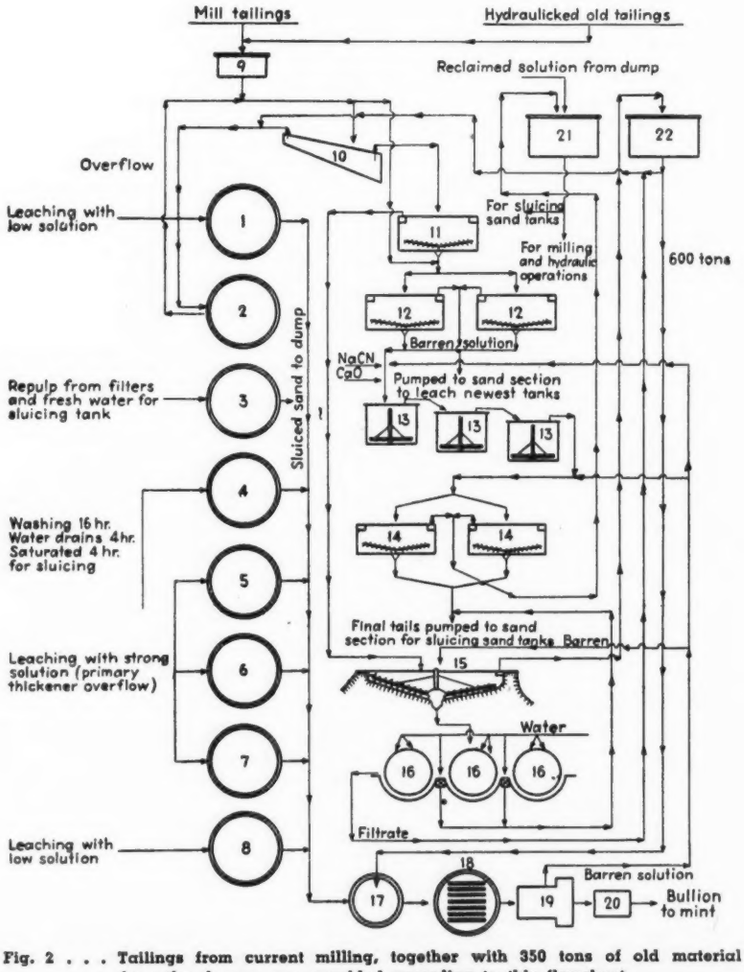

Mill tailings
Hydraulicked old tailings
Reclaimed solution from dump
Overflow
Leaching with low solution
For sluicing sand tanks
For milling and hydraulic operations
600 tons
Barren solution
NaCN
CaO
Pumped to sand section to leach newest tanks
Repulp from filters and fresh water for sluicing tank
Sluiced sand to dump
Washing 16 hr. Water drains 4 hr. Saturated 4 hr. for sluicing
Final tails pumped to sand section for sluicing sand tanks Barren
Leaching with strong solution (primary thickener overflow)
Water
Filtrate
Leaching with low solution
Barren solution
Bullion to mint

Fig. 2 . . . Tailings from current milling, together with 350 tons of old material from the dumps, are cyanided according to this flowsheet

Nickel in North Carolina

The silicate ores of Jackson County, long known, once more invite attention

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ABOUT FOUR YEARS AGO it was my privilege to present in these pages[1] some facts regarding the nickel situation in the United States with special reference to the sulphide resources of southeastern Alaska. Since then I have had occasion to observe and study some of the oxidized or silicate deposits of the world, notably those of the Soviet Union, the West Indies, and North Carolina, and I believe a discussion of them, especially of those at Webster, in western North Carolina, may be of timely interest.

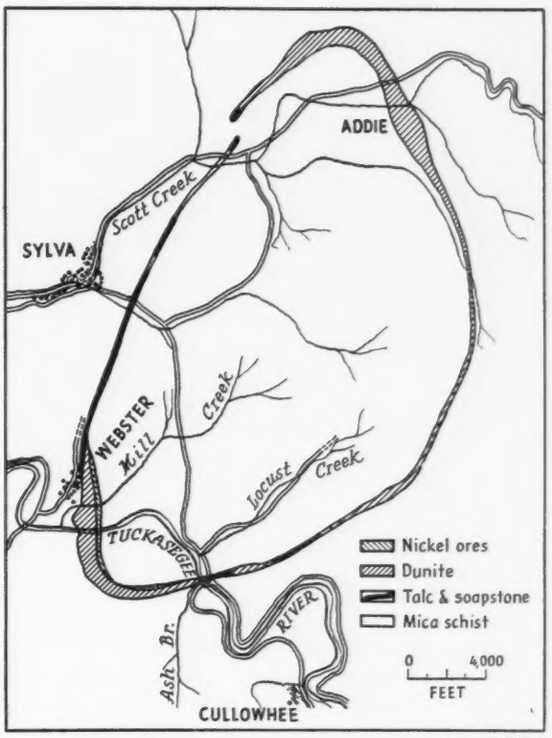
Compared to the sulphide nickel deposits, the silicates have contributed only a small portion of the world's nickel supply. The nickel-copper sulphides of the Sudbury Basin of Ontario furnish over 90 per cent of the world's nickel and practically 100 per cent of the amount consumed. Thus there is little cause for wonder that the silicates, which account for the remaining 10 per cent or less, should have been accorded little attention by the technical press.

No doubt the most important body of nickel silicates can still be claimed by the French island of New Caledonia, in the South Seas about 900 miles off the east coast of Australia. These deposits, discovered by the Frenchman, Garnier, who gave his name to the green hydrated nickel-magnesium silicate mineral, have been mined continuously for the past 60 years or more and, prior to the advent of the Canadian metal around 1890, contributed the bulk of the world's nickel. For nearly twenty years, between 1911 and 1930, a part of the annual output of 5,000 tons of Caledonian nickel was refined in the United States. Now the refining is mostly handled in Europe. It is a significant fact that the Japanese are attempting serious developments in the New Caledonian field to bolster the sources of supply for their budding nickel industry. Indeed, it is reasonable to expect increasing interest on their part in the Caledonian deposits because the tenor of the ores, which have been selectively mined for so many years, is now so low (around 5 per cent nickel) that it is difficult to see how they can much longer compete in the distant European market unless enlightened metallurgy comes to the aid of the low-grade raw material. The Japanese economy, like the Russian, can easily permit the handling of ores of half the present quality and value and will do so, provided, of course, that political considerations are favorable.

Next in importance, perhaps, are the silicates of the central and southern Urals of Siberia. Here in the low hilly steppe regions are found the deposits upon which the Soviet Government hopes to develop a sizable nickel industry.

Although the mineralized area is supposedly of great extent, the orebodies have not yet been fully explored and the available reserves are largely undetermined. Those bodies which have been opened indicate the run-of-mine quality to be around 2 per cent nickel. The nickel-bearing rocks, however, show much the same intense variations from high-grade mineral to barren gangue as are found in all the other silicate deposits of which we have knowledge.

The Soviet economic system makes it readily possible to utilize such low-grade and refractory material, situated in a most difficult section of the country and employing for the most part antiquated methods for the refining processes. One plant has been in production since the first "Piateletka," about 1933, on a 2,000-ton annual basis, and a second project of much larger capacity has been in course of construction near Orsk since 1935. Both of these plants will utilize the types of ores indicated in the accompanying table (Columns f and g), these being carefully mixed to secure the most advantageous smelting charges.



Courtesy T.V.A.

The nickel deposits at Webster, in Jackson County, are distributed as shown

These refineries, augmented by the expected production from the Nola, Norilsk, and Moncha Tundra projects, using sulphide ores which are likewise low in grade, will in time, the Russians hope, serve to render the U.S.S.R. independent of foreign sources of nickel supply. Such a patriotic aspiration may be hard to realize, however, in view of the meteoric rise in the Soviet demand for nickel, the latest figures showing that the Russian consumption is now at the rate of about 15,000 tons a year, second only to that of the United States.

In the West Indies, certain silicates, typical analyses of which are included in the table (Column e), have recently been examined by me. Though they offer considerable promise, they are as yet too little explored to justify more than passing mention at this time.

The Brazilian deposits, of which those in the province of Minas Geraes seem to offer the most promise, have to date proved somewhat disappointing, although their failure to produce the hoped-for tonnages is due to their inaccessibility rather than to any dearth of quantity or quality. The Germans appear to have been the most interested in the Brazilian resources, and the success they have had with their "Renn" process in handling this type of ore, containing as little as 1¼ to 1½ per cent of nickel,

makes it fairly certain that they will resume work at the earliest date possible.

Mention should be made here of the oxidized but not siliceous nickel deposits of Cuba. These lateritic ores, of Mayari Province, are so abundant that were it possible to recover economically the nickel and chromium contained in them, they would constitute a definite threat to the nickel supremacy now securely held by the Sudbury sulphides. Although they are the best known ores of their kind, huge deposits are found also in the south Urals, in Ceylon, Greece, and elsewhere. In Russia they are used for fluxing purposes and also for the production of the well-known Khalilovo naturally alloyed pig iron for high-quality cast iron, similar to the Mayari pig iron produced by the Bethlehem Steel Company.

Small deposits of the nickel silicates have been found in various other localities throughout the world, as in India, Germany, and Madagascar. One deposit at Riddles, Oregon,[2] has been known for many years and has had the benefit of some little investigation. It is similar to the Webster deposit in most particulars but appears to be neither as rich nor as extensive as the mineralized zones in Jackson County, western North Carolina. The nickel minerals of this county have long been the subject of interest because their apparent richness and easy accessibility held the promise that here might be established a domestic nickel industry. Numerous reputable engineers and geologists have examined the occurrences, but their reports are so varied and contradictory that it is impossible to form a conclusive opinion from them. The whole countryside around Webster is liberally honeycombed with old trenches and pits, some dug in the search for chromite as well as for nickel, and the vestiges of one shaft said to have been put down over 100 years ago by an English group searching for copper ore are still visible. Some tunneling and diamond drilling have also been done in the past, but the assay results for the most part have been lost.

Thomas Edison was one of those who were interested early by the promise of nickel and cobalt riches in this area. With a party he visited it in 1905. History records nothing of his impressions as to the two metals, but his opinion of the local roads of that day must have been definite, as we know that the two Fords in which the party traveled returned home via Southern Railway freight.

About 1910 Dr. C. T. Hennig erected and operated an electric-furnace reduction plant for the ores near Webster, and W. L. Morrison has presented[3] a résumé of the results achieved as well as some optimistic speculations on the possibilities of the nickel-bearing region. The remains of the old plant are still to be seen, as well as several tons of the ferronickel silicide produced at the time and which show an average analysis of 10 per cent nickel, 65 per cent iron, 20 per cent silicon, and 2 per cent chromium. Though the production costs of the metal smelted in the small electric furnace with high-cost energy generated from wood-fired boiler power manifestly precluded any chance of commercial success for the enterprise, it is not impossible that a similar operation today, using modern electric-furnace methods and cheap TVA power, with some degree of selective mining or ore beneficiation, could be carried on profitably.

Various Government geologists have been interested in the region over the years, and much information on its geology has been published by them. During recent months, when the subject of strategic minerals and the deficiency of nickel and chromite resources have been increasingly in the public eye, several Government men have reexamined the deposits, so their possibilities may yet be reinvestigated by Federal agencies.

Reference to the accompanying map provides a picture of the peridotite body which intruded the gneisses and schists of the district and which is held to be the parent rock of the nickel as well as the other varied minerals of the area. The dike takes the form of an almost unbroken elliptical ring about 6 miles long and 3½ miles wide, with its broadest sections near Webster on the southwest and Addie on the northeast, where the best nickel showings have been found. The dike provides most interesting hunting grounds for interested mineralogists. J. Volney Lewis[4] remarked, "In some respects the dunite area at Webster is the most remarkable outcrop of the whole Appalachian belt." Three members of the United States Geological Survey, Ross, Shannon, and Gonyer,[5] after an extensive study of the intrusive, sum up their impressions as to the nickel of the region by saying: "Silicates are found in many of the dunite areas of the Appalachian region, but they are probably more abundant at Webster, N. C., than at any other locality." They made careful examinations of the different strata found in the nickel belt, and their analyses of the important characteristic specimens are given in the table in Columns (a) and (b). These represent (a) "friable dark-red residual material 8 to 12 ft. thick underlying the red-brown surface soil" which grades downward into (b) yellowish porous material, "finally giving way to the fresh or partly serpentinized dunite."

Assays by Government and private investigators as well as the recent extended study of the region by me confirm the analyses obtained by Dr. Ross and associates and indicate that these red and yellow earths, carrying around 1.8 per cent NiO, make up the greatest proportion of the nickel-mineralized body.

The analysis of the apple-green serpentine given in Column (c) of the table is also from the report of the last-named investigators and checks many assays of similar materials found more or less plentifully but unevenly distributed throughout the laminated or disintegrated rocks. When present, these apple-green seams naturally serve appreciably to raise the quality of the adjacent orebody.

Column (d) of the table represents a fair average of many analyses made by me on samples taken over the large open cuts but near the surface; the analysis is also confirmed by assays on 51 bags of representative ore made by Griffiths, of London, who examined the material for platinum but found none. The soft nickel-impregnated soils wash away readily and samples taken below the area of surface influences are invariably richer in nickel than those which have been long ex-

Analyses of Some Typical Nickel Silicate Ores

Element	North Carolinan Ores: Dark Red Ores (a) %	Yellow Porous Dunites (b) %	Apple Green Serpentine (c) %	Typical Avg. Sample (d) %	West Indian Average (e) %	Akkermanski (f) %	Red Khalilovo (g) %	New Caledonian (h) %	Brazil Minas Geraes (i) %	Cuban Mayari Laterite (j) %
SiO_2	16.16	37.40	35.70	41.00	43.00	39.05	42.55	42.0	44.7	3.75
MgO	6.14	28.64	25.90	28.2	29.5	22.80	3.90	24.0	32.9	....
FeO	41.11	13.60	2.96	13.9	7.0	12.15	31.40	13.0	5.3	62.9
NiO	1.80	1.88	5.34	1.50	3.70	2.65	1.27	6.0	2.96	1.03
Al_2O_3	7.57	1.94	12.00	1.6	1.5	3.25	6.00	1.00	2.23	10.0
Cr_2O_3	2.81	0.42	.....	1.1	.....	.....	.....	Trace	....	2.0
MnO_2	0.26	0.08	.....	0.25	.....	.....	.....	0.7	....	0.9
CaO	0.10	0.34	.....	.....	.....	7.7	2.05	0.1	....	....
H_2O	17.76	13.64	12.00	10.00	15.00	.....	9.35	10.0	9.63	....

posed to the action of the weather.

As previously intimated, the dunite rocks of the peridotite intrusive carried the original nickel, and it was their weathering and the precipitation of nickel from downward-percolating solutions which account for the presence of nickel minerals in every crack and crevice of the highly fractured mass. That is the theory of most of the geologists who have studied the genesis of the deposits. A few, however, believe that the nickel originated from hydrothermal ascending, rather than descending, solutions. This question of origin is, of course, important, for on it largely depends the depth and persistence of the orebody. In spite of the fact that relatively large amounts of money have been spent in probing this question over the last forty years, the actual depth of mineralization has not been established, nor have the horizontal dimensions of the minable nickel ore been accurately delineated.

The basic unaltered rocks of the intrusive are mostly the light and dark green or yellow dunites, some partly serpentinized, carrying from nothing to 0.3 per cent of nickel with a somewhat greater percentage of chromite. Various alteration products or associated minerals, like talc, chlorite, serpentine, vermiculite, anthophyllite, and asbestos, appear scattered irregularly through the dike and one broad band of a deep-green pyroxenic dunite runs for nearly a mile near one edge of the broad section at Webster. This mineral called "websterite,"[6] because it was first described from this area, is of a richer green color than the adjacent olivines and carries readily identifiable crystals of green or yellow pyroxene and reddish bronzite.

As previously mentioned, some diamond-drill holes have been sunk to depths of over 300 ft. and several deep shafts have been dug, both before and during war-time investigations, but, although the verbal and other reports of the results are uniformly favorable, the actual records are obscure or lost, so that for all present purposes the earlier work has contributed little of real assistance in preparing tonnage estimates.

Based on the theory of impregnation by surface waters, however, most of the later investigators feel safe in stating their belief that mineralization extends only to the water table, which, in this locality, is said to be at a depth of from 60 to 100 ft. In our own recent operations, there seems to be a tendency for the ores to improve with depth—that is, to a depth of some 25 ft., which marks our deepest excavations. The broad talc-vermiculite seams which form important channels or carriers of the rich nickel mineralization downward almost always come in or thicken at lower levels, and many such veins which do not rise to pierce the gossan show up strong at fairly shallow levels.

Scrapers were employed in exploring the nickel deposits near Webster

These vertical or obliquely descending rich veins or nickel carriers vary from an inch to a foot or more in thickness and are uniformly filled with a gray to green talc-anthophyllite or vermiculite or both, more or less heavily impregnated with garnierite. Perhaps it were more accurate to say that the nickel had entered into chemical combinations with these basic silicates, particularly with the vermiculite, replacing the magnesium and forming complex nickel minerals. It is interesting to note that the walls or linings of these veins are uniformly composed of an amphibole in which the fibres extend at right angles to the dip of the seam. On each side of these rich seams the red earth shows correspondingly high nickel contents, the values diminishing with the distance from the vein.

When the structure is rocky—that is, when the dunite is not completely decomposed into the reddish "hematite" earth—the interstices and crevices of the heavily fractured mass are permeated with the green mineralization, so that the ore of this character may be equally as rich as the earthy carriers, which have, in effect, soaked up and retained the nickel like a sponge.

One, therefore, finds all shades of color in a silicate nickel deposit, from the primary solid green olivine, carrying little or no nickel, through yellow, tan, brown, and finally deep red, in which hydration has extended to the limit and most of the magnesia of the original dunites has been removed and the iron oxides concentrated in place. Through it all the apple-green genthite or garnierite persists and shows up in every fresh opening. Quartz or chalcedony stringers are abundant, especially in the softer sections, and this mineral, although sometimes green in color, seldom carries more than a trace of nickel. Now and then strong showings of chromite and pyrolusite come into the picture, supplying the browns and blacks to complete the color scheme.

Much the same sort of structure is reported from every garnierite deposit of which I have knowledge. The large open pits of the Ufalei mines on the steppes of the middle Urals, incidentally over a hundred feet in depth, present almost a perfect replica of the shallower trenches we see at Webster.

Excellent maps of the peridotite dike are available and the one reproduced herewith is taken from a recent publication[7] of the TVA. The text accompanying the map describes the nickel occurrence "occupying a zone two miles long and one-tenth of a mile wide along the inside of the crescent," the richest portion appearing contiguous with the contact of the gneiss or schist where the dunite fracturing was the most pronounced. This reference is to the deposit nearest the old mill, where the greatest amount of exploratory work has been done and where the best showings have been found. The report also mentions "other places along the dike where small nickel deposits may be found." If only a fraction of the nickel-bearing material may be classed as ore carrying 1 to 1½ per cent of nickel, the

deposit is one that is worthy of consideration.

Mining conditions in the Webster district are good. The surface deposit is not encumbered with heavy overburden and could readily be mined by steam shovel or dragline. The climate is excellent the year around; likewise the conditions as to transport, labor. power, and water. It is hard to refrain from comparing these conditions with those "enjoyed" by the Russian enterprise handling almost identical ore, thousands of kilometers from supplies and markets, frigidly cold for half the year, with poor transport and high fuel, power, and other charges (except labor). Of course, the Soviet economy is different.

As in New Caledonia, it would be possible to practice selective mining at Webster, thereby yielding an ore running, say, 3 to 4 per cent of nickel. Such procedure would, of course, automatically cut down the available ore supply and impoverish the remaining portion, probably rendering it unamenable to future commercial treatment. Serious attempts have been made at beneficiating the run-of-mine ore by the usual means of mechanical concentration, but with only partial success, because, as previously explained, the nickel is not freed by any fineness of grinding. About the best results thus far achieved have been by electrostatic means and by a combination of screening and washing wherein some 80 per cent of the original 1 per cent plus nickel material is beneficiated by about 30 per cent (that is, carrying 1.3 per cent Ni) and the remaining 20 per cent of tails carrying 0.3 to 0.4 per cent of nickel. These methods, however, are not satisfactory, and other means of beneficiation are being studied, involving the recovery of byproducts also.

An official of the United States Bureau of Mines as long ago as 1912, in referring[8] to the "immense deposits of low-grade nickel silicates occurring at Webster, N. C.," stated that, "owing to their low nickel content, no method of commercially treating them has as yet been found." "Of course," he continued, "the same statement was true of similar ores of copper ten years ago." It remains to be seen whether now, after 27 years, we are nearer to a solution of the economic exploitation of these deposits.

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Placering In Mindanao With Dragline and Stacker Scow

Gravel washed in one month totaled 43,500 cu. yd. and yielded 34 1/2 cents per yard, or 89 1/2 per cent of the assay value

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AT PRESENT lode mining far overshadows placer operations in the Philippine gold mining industry. Of the total output of 922,126 oz. produced in 1938, only 36,840 oz., or about 4 per cent, came from placer mines. These included a major dredging operation at Paracale, which accounted for 31,630 oz., the remainder being derived from a hydraulic operation at Surigao, a bucket dredge at Tambis, and a dragline operation, of the type unhappily named "doodlebug," in Zamboanga. Recently another dragline placer operation was running in central Mindanao.

The method of working limited areas of gold placer ground by means of a dragline with pontoon-mounted floating washing plant and tailings stacker, such as has been used with considerable success in California and other parts of the Western United States, has often much to recommend it. The initial capital expense is less than for a bucket dredge, the equipment can be dismantled and moved without undue difficulty to other areas when the original ground is worked out, and operating costs, considering the relatively small yardages handled, are often creditably low.

Other engineers have pointed out that favorable operating conditions for a dragline operation call for shallow uncemented gravels, with few large boulders, soft bedrock, and adequate water supply. I have seen boulders occurring in the gravel handled with comparative ease by experienced dragline operators, if not of undue size, and their disposal on the grizzly is not difficult. Of more concern in the tropics is the liability of sudden and disastrous floods from torrential rainfall, that may sweep out dams and wreck the washing plant. Most placers are situated far from repair shops or sources of supply, and a breakdown, such as is bound to occur occasionally with the equipment, results in cessation of operations until repairs can be made. Hence it is always necessary to carry a full stock of repair parts at the *bodega*, and a welding plant is an absolute necessity, with an experienced, resourceful operator.

At the property of the Mindanao Mining Company, which recently was operating a dragline and floating washing plant on the Tuba Flat area of the Curuan River, 50 km. north of Zamboanga in southern Mindanao, conditions are rather favorable for efficient work. The gravels occupy the present river bed, which is about 600 ft. wide and meanders between moderately rising banks on either side. In the dry season the flow of the Curuan River is hardly more than 1,000 g.p.m., but in the rainy season it may become a torrent in a few hours' time. The placers are present in the river bed as well as deposited in benches, and are definitely related to the present stream system. They vary in depth from 6 to 30 ft., and average about 15 ft. The gravel is not cemented, and is free from clay, but the percentage of boulders, usually of moderate size, is large, and may be as much as 30 per cent of the ground.

The source of the placer gold appears to have been from the erosion of innumerable small quartz gold-bearing veinlets that occur in a schistose belt extending from the Curuan River back to the mountains. The gold is sometimes quite coarse, and amalgamates well in sluice boxes. The fineness, over 900, is unusually high for placer gold in the Philippines. Test holes indicated that most of the gold

was concentrated at or near the bedrock, although some values are encountered throughout the entire thickness of the gravel, and this has been borne out by mining operations. It has also been found, as might be expected, that spots of local enrichment are often encountered close to the inside bends of the stream and the benches adjacent.

The ground had been thoroughly tested by shafts 4x4 ft. in cross-section, sunk on 100-ft. centers for a distance of some 5,000 ft. along the Tuba Flat. There was a row of shafts spaced 200 ft. apart, so that there were four per acre. These shafts were sunk by hand to bedrock unless water flow interfered, and the entire amount of excavated material was washed in a sluice box, and the colors were collected, weighed, and amalgamated. Knowing the volume in cubic yards of the shaft, the average value per cubic yard was easily calculated. In addition, a cut 12 in. square was taken down one side of the shaft, and panned at 2-ft. intervals. Colors were counted and classified as coarse, medium, and fine, to determine the distribution of the gold throughout the gravel. About 2½ ft. of shaft could be sunk in an eight-hour shift with four men and a *capataz*, or 1.5 cu.yd. This made the cost of sinking a 20-ft. shaft, with wages at 1 peso (50c. U. S. currency) per day for laborers, about 32 pesos, exclusive of supervision, or 2.70 pesos per cubic yard. The average value of the ground, according to the test shafts, was found to be 0.66 peso per cubic yard.

The dragline of the Mindanao Mining Company and the washing plant, the latter mounted on a scow. The area worked is on the Tuba Flat of the Curuan River in southern Mindanao

Diesel Power Used

During a dredging period of sixteen months, over 450,000 cu.yd. of gravel was put through the plant. Operations were on a scale far smaller than warranted by the capacity of the plant and dragline, which was rated at 3,500 cu.yd. per day of twenty hours. Delays were caused mainly by moving, breakdowns, and lack of water during the dry season. During March, 1939, 40,100 cu.yd. of gravel was washed and 6,220 cu.yd. of overburden removed. Of the total working time, 261 hours was required for stripping and 105 hours in washing. Thus the actual capacity of the plant, during production, was 154 cu.yd. per hour.

The washing plant used was of conventional design, consisting of a pontoon-mounted barge, equipped with grizzly, trommel, riffle tables, and tailings stacker. A diesel engine furnished power for the plant, including a 10-in. 2,200-g.p.m. centrifugal pump for washing the gravel. Grizzly bars were spaced 12 in. apart, and were built up by welding flat iron around triangular wood blocks 5½-in. wide. These were said to stand up better than rails under the impact of the boulders. Four men were used on the grizzly. As a bucket was dumped, the boulders were thoroughly washed to free them from clay, then removed with hooks and run off through chutes on either side of the grizzly into the pond. From the grizzly the undersize material went to a trommel, with 7/16-in. holes at the head section and ¾-in. holes at the end section. Undersizes went to the riffle tables and oversize to the tailings stacker. Riffles were of the Hungarian type, containing a liberal amount of quicksilver to catch the fine gold, which has a tendency to float off in the slimy water. Mercury traps were provided for excess quicksilver that might escape, as well as amalgam that might be carried away, but there was naturally some loss.

The dragline, a No. 55 Bucyrus-Erie, powered by a diesel, was originally equipped with a 2½-cu.yd. bucket. This was changed over to one of 3-cu.yd. capacity weighing 6,200 lb. with beneficial results in deeper ground. Shovel points lasted only eight to ten hours and were built up by electric welding.

The bedrock is hard, but a shaly layer on top is soft, and could be broken up and removed by the bucket. The overburden, about 3 to 6 ft. thick, was taken off by a caterpillar bulldozer, and piled to one side, making a solid footing for the dragline. A smaller caterpillar was used as a utility machine, for hauling supplies or aiding in dam construction.

One of the disadvantages of using a dragline in recovery of gold from placer gravels is that the constant churning up of the gravel, due to the intermittent operation of the bucket, tends to result in the gold particles settling to the bottom, making recovery difficult and incomplete. This is particularly true where the gold is more or less concentrated on the bedrock, which is difficult to clean with the bucket, and which, on the Curuan River, was too hard to be broken up. Early operators were unable to get a good recovery from the ground in consequence, which yielded only 50 per cent of the tested values. By using a heavier bucket, better results were obtained, and the unusual idea was also adopted of dumping some of the clayey overburden on the bedrock when it was reached, then picking up the clay again and putting it through the washing plant. It was found that the clay acted as "a gold catcher," and recovered much of the gold that had found its way to the bedrock and was not recoverable by other means. The results were gratifying in additional gold recovery. From 43,500 cu.yd. washed in a month's time, 27,123 pesos was recovered, or 0.62 peso per cubic yard, compared with a value according to the test pits of 0.692 peso per cubic yard, indicating a recovery of 89.5 per cent of the assay value of the gravel.

Some 35 men were employed at the mine, including an American staff of a superintendent, a general foreman, and two skilled dragline operators. The over-all costs of operation, before capital charges, depreciation, or depletion, were 0.23 peso per cubic yard, comparing well with California costs of 8 to 16c. per cubic yard on installations of similar capacity. The original capital costs were naturally much higher than in the United States, due to ocean freight charges, transportation into the interior, and higher costs for erection and construction.

Some Suggestions on the Transmission of Compressed Air

A critical review of the subject

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IN REVIEWING the various published formulas for drop in pressure in compressed-air lines, it became increasingly evident that an engineer in the field, without a library at his disposal, would find it difficult not only to evaluate the validity of the various formulas, but even to use them, because of misprints or insufficient definition of symbols. As to applying some of the formulas at different altitudes, it would be quite impossible without deriving the formulas.

As compressed air flows through a pipe the turbulence causes the conversion of mechanical energy into heat, with consequent drop in pressure. As the pressure drops, the velocity increases, so that the air is continually accelerated as it flows.

Expansion is continually taking place in the pipe, and the work of expansion is converted into heat and increase of kinetic energy. The increase in kinetic energy in a properly designed pipe line is negligible in its effect both on pressure drop and temperature, and so may be disregarded. Expansion cools the air, but the equivalent of the work done by the expansion becomes heat and goes back into the air and heats it to the original temperature; so it may be stated that once the pipe has reached the temperature of the surroundings, the air from that point on flows along at constant temperature. The only factors that might cause cooling are the increase in kinetic energy, and the Joule-Thompson effect, but both are negligible.

The Hydraulic Formula — The parent of the valid air flow formulas is the hydraulic formula for turbulent flow, with an added term representing the effect of expansion in a duct of constant area, which, stated in its entirety, is as follows:

$$\Delta P = \frac{f\, w\, L\, v^2}{R\, 2g} + \frac{W}{Ag}\, \Delta v$$

ΔP = Drop in pressure in lb. per sq.ft.
f = Friction factor.
w = Density in lb. per cu.ft.
v = Average velocity in ft. per sec.
L = Length of duct in feet.
g = Acceleration due to gravity (32.2).
R = Hydraulic radius, $\left(\frac{\text{Area}}{\text{Perimeter}}\right)$ in feet.
W = Weight of air flowing per sec.
A = Cross-sectional area of duct in sq.ft.
Δv = Change in velocity in length L.

The second term on the right-hand side of the equation shows the effect of increase in velocity on the pressure drop. This may be neglected, as its effect is small. The hydraulic radius of a circular pipe is $\frac{D}{4}$, where D is the internal diameter in feet, so the formula becomes

$$\Delta P = \frac{4f\, w\, L\, v^2}{D\, 2_g} \qquad (1)$$

Constant-Density Formulas — The simplest and much-used formulas for the flow of air take no cognizance of the change in density and increase in the velocity of the air as it flows along the pipe. For ventilation work, where constant density is assumed, formula (1) is thrown into the form

$$\Delta P = \frac{c\, w\, S\, V^2}{A} \qquad (2)$$

ΔP = Drop in pressure in lb. per sq.ft.
c = Friction factor.
w = Density in lb. per cu.ft.
S = Rubbing surface in sq.ft. (Perimeter × Length)
V = Average velocity in ft. per min.
A = Cross-sectional area in sq.ft.

The factors c x w are often united to form the factor K and the formula with K replacing c x w is known as the Atkinson formula. The factor K is usually evaluated for a density of 0.075 lb. per cu.ft., so if the air under consideration is at some other density, X, the value of K must be multiplied by $\frac{X}{0.075}$

The following relation holds between factors c and f

$$c = \frac{f}{2g \times 3{,}600}$$

Coming now to compressed air, the most widely used constant density formula is that of Harris.[1]

$$\Delta p = \frac{C\, L\, Q^2}{r\, d^5} \qquad (3)$$

Δp = Drop in pressure in lb. per sq.in.
C = Experimental factor.
L = Length of pipe in feet.
Q = Volume of "free air" flowing per second in cu.ft.
r = Ratio of compression at entrance of pipe. $\left(\frac{\text{Absolute Pressure of Air}}{\text{Atmospheric Pressure}}\right)$
d = Actual internal diameter in inches.

The term "free air" is used differently in different formulas. "Free air" in the accepted use of the term means atmospheric air measured at the temperature and pressure of the particular place. In some formulas "free air" means air measured at an assumed pressure and temperature. Such air should be termed "standard air." The pressure of such is usually

[1] Harris, E. G.; Bulletin of the School of Mines and Metallurgy, University of Missouri, Vol. 1, No. 4, 1912.

assumed to be 14.7 lb. per sq.in. and the temperature 60 deg. F., but these values can be anything if the assumptions are stated.

The term "free air" as used in the Harris formula means atmospheric air measured at the temperature and pressure of the place, which is the correct use.

To understand the Harris formula it is necessary to consider a few points in its derivation. Starting with formula (1), Q enters the formula by substituting $\frac{Q^2}{A^2}$ for v^2. To determine the volume of compressed air, assuming its temperature is the same as that of the atmospheric air, it is necessary to divide Q by r, the ratio of compression, so r^2 enters the denominator. In the derivation, w at the start is the density of atmospheric air, so if compressed air is flowing, w must be multiplied by r, and this cancels an r in the denominator, leaving r in the denominator. The formula would be more accurate if Q were the number of cubic feet at atmospheric pressure and at the temperature of the compressed air.

Experimental Factor

The experimental factor C, then, contains the friction factor multiplied by the density of atmospheric air at Rolla, Mo., together with certain constants. Thus, if a calculation is to be made at an altitude differing from that at Rolla, the factor C must be multiplied by

$$\frac{\text{barometric pressure at place in lb. per sq.in.}}{14.2}$$

assuming that the temperature is the same as when C was determined. The constant density formula should be used only when the drop in pressure is small. It assumes that the drop in pressure is proportional to the length of the pipe. This is not true, for with decreasing density and increasing velocity, with steady flow the drop in pressure in each increment of length is greater than in the preceding increment.

To paint an accurate mathematical picture of what happens, it is necessary to take into consideration the changing density and increasing velocity by integration. The resulting formula which I have derived is one of its many forms:

$$p_1^2 - p_2^2 = \frac{0.00021\, f\, Q_s^2\, T\, L}{d^5} \qquad (4)$$

p_1 = Absolute pressure at start in lb. per sq.in.
p_2 = Absolute pressure at end in lb. per sq.in.
f = Friction factor.
Q_s = Cubic feet per min. flowing measured at 14.7 lb. per sq.in. and 60° F.
T = Absolute temperature of air in pipe in deg. F. (Fahrenheit deg. + 460)
L = Length of pipe in feet.
d = Actual internal diameter in inches.

Any of the formulas derived from formula (1) by methods of integration may be reduced to this form. No valid formula can give the drop in pressure directly.

In formula (4) the temperature may be assumed to be 60 deg. F. and the factors 0.00021x520xf combined into a factor m. This formula then takes the form

$$p_1^2 - p_2^2 = \frac{m\, Q_s^2\, L}{d^5} \qquad (5)$$

Some claim the value of m should be 0.0005 and some use 0.0006. In any case m contains an approximate average value of f. In handbooks the quantity term is defined as "free air" per minute, which, as seen from the derivation, is not the "free air" used in the Harris formula, but air measured at a definite temperature and pressure. This formula has, in my opinion, no virtue.

The Unwin formula[2] is

$$P_1^2 - P_2^2 = \frac{P_1^2\, U_1^2\, f\, L}{g\, C\, T\, m} \qquad (6)$$

P_1 = Initial absolute pressure lb. per sq.ft.
P_2 = Final absolute pressure lb. per sq.ft.
U_1 = Initial velocity ft. per sec.
f = Friction factor.
L = Length of duct in feet.
g = 32.2.
C = Gas constant for air (53.3).
T = Absolute temperature, deg. F.
m = Hydraulic radius in feet.

This formula may be reduced to formula (4) and the f is the same as in formula (4).

The Friction Factor "f"—The roughness of the pipe exerts the greatest influence on the value of the friction factor.

Many experiments in the flow of fluids have shown that the friction factor f for similar ducts is a function of the expression $\frac{d\, S\, V}{Z}$ where d is the diameter, S the density, V the velocity, and Z the viscosity. This expression is called the Reynolds' number. The larger the value of Reynolds' number, the smaller the value of f. The doctrine of similarity extends even to the degree of roughness of the pipe. A pipe that is twice as large is not ordinarily twice as rough, so a curve showing the factor plotted against Reynolds' number must, in any event, be made for every size of pipe.

In recent work in hydrodynamics the factor 4 from the hydraulic radius is combined with f, so that the friction factor in much of the hydraulic data is four times as large as the value of f used in this paper for any given value of the Reynolds' number. I have omitted the factor 4 to conform with most of the writers on air flow.

The Reynolds' number does not change as the air flows along the pipe, because density x velocity remains constant. The number may be computed at the start of the pipe line.

The only experiments on compressed air flow that I have observed correlating f with the Reynolds' number were made on a pipe with a nominal diameter of $1\frac{1}{4}$ in. The value of the friction factor did not decrease with increase of Reynolds' number, but showed a fairly constant value of a little over 0.007. It is possible that the increase in velocity sets up a type of turbulence which is not quite the same as in constant density flow.

Mine Air Density

In mine work the density of the air is not much different from the density existing at the time the factors to be used were determined. The effect of viscosity which depends only on temperature is, according to Fritzsche, negligible. If the friction factor decreases with increasing velocity, the only effect of using velocity beyond the range of good practice would be to have a factor a little smaller than was estimated.

Considering the difficulty of obtaining values that check, even in consecutive runs, and considering the variations in the surface of the pipe, it is my belief that expressions for the factor involving only the pipe diameter are sufficiently accurate for all work.

The difficulty in obtaining identical friction factors, with all conditions apparently the same, is probably due to the varying amounts of condensed water and oil on the surface. A pipe with a wetted surface has a higher friction factor than a dry one. This was demonstrated by L. M. K. Boelter and Robert Kepner in experiments carried out in the Department of Mechanical Engineering of the University of California.

Great difference in density undoubtedly does affect the factor, as is indicated in the Reynolds' number. The factor for ventilating air is higher than the factor for compressed air in the same size of duct.

The Harris Equation—The value of C for the Harris formula (3) is defined by the formula

$$C = \frac{0.1{,}025}{d^{0.31}}$$

C = Experimental factor.
d = Actual inside diameter of pipe in inches.

The value of C was calculated from measurements inserted in formula (3), a constant-density formula, but Harris used such short lengths of pipe that the effect of changing density would not be sufficient to invalidate it.

As seen in formula (4), the temperature of the compressed air affects

[2] Unwin, W. C.: "On the Development and Transmission of Power," Longmans, Green & Company, 1894.

the drop in pressure, and the Harris formula does not take this into consideration.

It must be remembered that C is analogous to K in the Atkinson formula, as it has a density of about 0.073 concealed in it as a factor. Using this density and 32.2 for g,

$$f = 0.079\,C$$

The accompanying table gives Harris's values of C and the values of f computed therefrom.

From personal observation, I am quite sure the factor for 1¼-in. pipe, which is near one end of the range, is correct.

An accurate check for the large pipes should be obtained from the Unwin formula for f, which is based to a considerable extent on the work on the large mains of Paris.

The Unwin Formula for "f"—

$$f = 0.0027\left(1 + \frac{3.6}{d}\right)$$

d is the diameter in inches.

For a 12-in. pipe

$$f = 0.0027\left(1 + \frac{3.6}{12.09}\right) = 0.0035$$

By the Harris formula f=0.0038. I think that the Unwin formula gives too high results on small pipes. For 1¼-in. pipe

$$f = 0.0027\left(1 + \frac{3.6}{1.38}\right) = 0.0098$$

as compared with 0.0072 from the Harris experiments.

The factor m in formula (5) should yield nearly average results for f. The values for the two different values of m in use would be

$$f = \frac{0.0005}{0.00021 \times 520} = 0.0046$$

$$f = \frac{0.0006}{0.00021 \times 520} = 0.0055$$

According to Harris, these are the factors for 6-in. and 3½-in. pipes. I believe that the use of the Harris values, although derived from a rather questionable formula, will give sufficiently accurate results over the entire range of sizes.

Ventilation Work—For ventilation work where pressures are high enough to require a centrifugal blower or positive pressure blower, I would recommend the use of formula (4) with a value for f of 0.005 for sheet-metal pipe in perfect condition, in sizes 12 in. and over.

For low-pressure work the Atkinson formula is used with a value of K=0.0000000015 for a density of 0.075 lb. per cu.ft.

Friction Formulas With Fractional Indices—If an expression for the friction factor in terms of various factors such as density and velocity is evolved, this expression is sometimes multiplied into the friction formula, usually resulting in a formula with fractional indices. It is much better to keep f separate in the formula.

Solution of the Friction Formula (4)—The easiest way to solve the formula with the slide rule is as follows:

$$p_1^2 - p_2^2 = \frac{f\,Q_s^2\,T\,L}{d^5}$$

Call the right hand side n and factor $p_1^2 - p_2^2$ into $(p_1 + p_2)\,(p_1 - p_2)$
Then

$$p_1 - p_2 = \Delta p = \frac{n}{p_1 + p_2} = \frac{n}{2p_1 - \Delta p}$$

Calculate n with the slide rule and divide by $2p_1$, which is known, and an approximate result is obtained for Δp. Subtract this from $2p_1$ and divide again. Two or three divisions are enough.

If it is desired to find the diameter to transmit a given amount of air with a given drop in pressure, solve the formula for d. The factor f is not known because d is not known. Determine d approximately from one of the tables for the Harris formula (3) which can be found in various sources of compressed air data. A table can be found in a recent booklet published by the Compressed Air Institute,[3] and also in reference[1] cited.

Select proper value of f from table given in this paper. If the d now determined with formula (4) differs much from the one found from use of table, select new value for f and repeat.

Type Problem—It is desired to transmit 850 cu.ft. of free air through 5,000 ft. of 3½-in. pipe. The temperature of the atmospheric air is 70 deg., and the barometric pressure is 10 lb. per sq.in. The temperature of the air in the pipe line is 100 deg. F. The gage pressure is 90 lb. per sq.in. at the start. What is the drop in pressure?

$$p_2^2 = p_1^2 - \frac{0.00021\,f\,Q_s^2\,T\,L}{d^5}$$

f from table is 0.0054

$$Q_s = 850 \times \frac{10}{14.7} \times \frac{520}{530} = 568$$

d = 3.55

p_2^2 = (100)²—

$$\frac{0.00021 \times 0.0054 \times (568)^2 \times 560 \times 5{,}000}{(3.55)^5}$$

$p_2^2 = \sqrt{10{,}000 - 1{,}817}$
p_2 = 90.5 lb. per sq.in. abs.
$\Delta p = p_1 - p_2 = 100 - 90.5 = 9.5$ lb. per sq.in.

Solution of Same Problems by Means of Tables for Harris Formula—Always use the tables that give a factor to be divided by the ratio of compression to obtain drop in pressure. For 850 cu.ft. of "free air" in 3½-in. pipe the factor given is 24.4. This divided by 10, the ratio of compression, gives 2.44 lb. per sq.in. for 1,000 ft. For 5,000 ft. the drop is 12.20 lb. per sq.in.

Solution, Applying Suggested Corrections—850 cu.ft. of air at 70 deg. $= 850 \times \frac{560}{530} = 900$ cu.ft. at 100 deg., the line temperature.

The factor for 900 cu.ft. is 27.4. Dividing by 10, the ratio of compression, the drop in pressure is 2.74 per 1,000 ft. For 5,000 ft. the drop in pressure is 13.70 lb. per sq.in. Applying the barometric correction for factor C,

$$\frac{10}{14.2} \times 13.70 = 9.65$$

which checks closely with the result given by formula (4).

Harris's Values of C and the Values of f Computed From Them

Nominal Diam. in.	½	¾	1	1¼	1½	1¾	2	2½	3	3½	4	4½	5	6	8	10	12
C	0.170	0.107	0.099	0.091	0.087	0.084	0.081	0.0765	0.0715	0.0685	0.066	0.0635	0.0615	0.058	0.0535	0.05	0.048
f	0.013	0.0085	0.0078	0.0072	0.0069	0.0066	0.0064	0.0060	0.0057	0.0054	0.0052	0.0050	0.0049	0.0046	0.0042	0.0040	0.0038

Summary—The flow of air in pipes is discussed. The origins of the different formulas for drop in pressure are shown and the limitations and advantages of the different formulas indicated.

The nature of the friction factor is discussed and a table of suitable values provided.

It is recommended that for compressed-air work the formula derived by integration from the turbulent flow formula be used, and that the friction factors be the values derived from the work of Harris as presented in the table that is presented immediately above.

For high-pressure ventilating work the same formula should be used with a constant friction factor.

It must be realized that tests are usually made on pipes in good condition. If a pipe is rusty the friction factor is increased. With old pipe, it might be well even to double the friction factors given. To my knowledge, no definite data on the subject with respect to formulas for old or rusted pipe exist.

[3] Trades Standards, Compressed Air Institute, 90 West St., New York, N. Y.

Copper Finds Widening Use In Industry

The metal has become an important alloying element for steel and cast iron

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FEW MINING ENGINEERS appreciate the extent to which the iron and steel industry uses copper as an alloying element. Men familiar with the industry estimate that in the past year from ten to fifteen thousand tons of copper was consumed in the form of alloy additions to steel and cast irons. This market is expanding as the effects of copper on the properties of iron and steel, its useful applications, and its limitations become better known to the producers and the users of iron and steel products.

The first deliberate use of copper in steel occurred some thirty years, when copper-bearing steels were made with claims for improved corrosion resistance. Though long contested, these claims were justified. It is now known that about a quarter of 1 per cent of copper (4 or 5 lb. of copper per ton of steel) doubles or triples the life of steels exposed to ordinary atmospheric corrosion. Greater proportions of copper alone do not normally confer additional corrosion resistance, so that the term "copper-bearing steels" has come to mean specifically steels containing from two- to three-tenths of 1 per cent of copper. In 1937, 4,600 tons of new copper was reported used in the manufacture of copper-bearing steels.[1]

Only in the last few years has metallurgical research brought further practical progress in the use of copper in steel and iron, but recent advances have been great. The steel manufacturers, the foundries, and the copper industry itself have all made contributions, with the result that copper now ranks as an important alloying element for steel and cast iron.

Corrosive Resistance

Wrought Steels—The use of 0.25 per cent of copper to improve the corrosion resistance of wrought steel has been mentioned. In 1926 a new Toncan metal was developed by the Republic Steel Company. This steel contained up to 0.5 per cent copper combined with 0.10 to 0.25 per cent molybdenum, and had still better rust resistance. Quite recently it has been found that one-tenth of 1 per cent of phosphorus likewise accents the corrosion-resistant effects of copper, particularly with copper in excess of the usual 0.25 per cent. The copper-bearing plain steels and alloy steels of this type now find wide acceptance, particularly for services demanding good resistance to atmospheric corrosion, even though much of this tonnage is given primary protection by galvanizing or painting, or both.

A development of greater significance to the copper industry is the advent of the so-called low-alloy, high-strength steels that have appeared in the last five years. Almost every steel producer now makes one or more of these steels. They are "proprietary steels," each given an identifying trade name. In the as-rolled condition, combining high strength with corrosion resistance, weldability and relatively low cost, they form a new and unique group of steels.

Low-alloy, high-yield strength steels, to give them their full designation which recognizes the current design emphasis on yield strength rather than tensile strength, are produced chiefly as plate, sheet, light structural shapes, and wire. Table I gives representative compositions and corresponding properties of several of the group. These steels can be welded without adverse effects. It will be noted, in comparing them with ordinary structural steel, that the yield strengths have been materially increased with a relatively smaller increase in tensile strength and practically no drop in per cent elongation.

[1] Yearbook of the American Bureau of Metal Statistics, 1938. Assuming that residual copper in average open-hearth steel runs approximately 0.10 per cent, this consumption of new copper would result from the manufacture of, roughly, 3,000,000 tons of copper-bearing steel.

Table I—Representative Compositions and Corresponding Properties (Not Specification Limits). Low-Alloy Steels for Welding Without Preheating or Stress-Relieving Annealing.*

Usual requirements: 50,000 lb. per sq. in. min. yield strength, 21% elongation on 8 in. up to 1-in. plate, longitudinal specimens. As rolled ¼ – ¾-in. plate or 1-in. rod unless noted.

No.	Approximate Composition									¼b. per sq. in.		Elongation on 8 In.	Reduction of Area,
	C %	Si %	Mn %	P %	Cu %	Cr %	Ni %	Mo %	V %	Yield Strength	Tensile Strength	%	%
A	0.20	0.15	0.50	....	....	....	....	....	....	32,000	60,000	25	55–60
1	0.13	0.15	0.90	....	0.20 (a)	....	....	0.50 (b)	....	50,000	80,000	23	55
2	0.16	0.20	1.20	....	0.20 (a)	....	....	....	0.10 (d)	60,000	80,000	21 (e)	60–70
3	0.14	0.70	1.10	....	0.20 (a)	0.50	....	....	....	50,000	75,000	25	40
4	0.08	0.05	0.38	0.11	0.65	....	0.75	0.10	....	50,000	70,000	27	60
5	0.09	0.40	0.70	0.10	0.60	0.25	0.33	....	....	50,000	75,000	25	..
6	0.10	0.50 max.	0.75	....	0.50	0.25 max.	0.25 max.	....	....	50,000	70,000	25	..
(c) 7	0.10	0.30 max.	0.60	0.10	1.10	....	0.55	....	....	50,000	75,000	25	60
8	0.09	....	0.70	....	1.40	....	0.80	0.10	....	55,000	70,000	25	50
9	0.10	0.75	0.20	0.13	0.40	0.90	....	....	....	50,000	70,000	25 (f)	..
10	0.08	0.30 max.	0.55	....	1.00	....	2.00	....	....	55,000	75,000	25	60

* From Williams, C. E.: "Recent Developments in the American Iron and Steel Industry," Jl. Iron and Steel Institute, No. II, 1938.
A Structural steel. (a) Copper content when copper is desired. (b) For heavy sections; 0.25% molybdenum for light sections. (c) Atmospheric corrosion resistance greater than for copper-bearing steel is claimed for steels Nos. 4–10. (d) Content slightly above the usual level for this class, due to fine grain conferred by vanadium. Manufacturers allow 0.18% carbon max. (e) Elongation 28% on 2 in. (f) On 2 in.

Copper is used in these steels in proportions ranging from 0.20 to 1.40 per cent. Up to 0.5 per cent, in conjunction with other elements, notably phosphorus, it contributes increased corrosion resistance. The claim is made for some of these steels that their resistance to ordinary atmospheric corrosion is two or three times that of the ordinary copper-bearing steels, which means an indicated life of six to eight times that of the plain carbon steels.

Above 0.5 per cent, copper increases the strength as well as the corrosion resistance. A specific effect of copper is its tendency to increase the yield strength much more than the tensile strength. To metallurgists and designers a high ratio of yield to tensile strength indicates a combination of strength, ductility, and toughness which is of particular advantage in the construction of high-strength low-weight equipment.

Nickel Aids in Rolling

Some special provisions may be necessary in the manufacture of copper-alloy steel, as more than 0.5 per cent copper may affect the surface in hot-rolling. Good surfaces are obtained by keeping rolling temperatures low or by adding small amounts of nickel. Until knowledge of these special precautions became available, the surface checking of the copper steels when hot-rolled led to the erroneous conclusion that copper steels were "hot short"—that is, brittle—so that they cracked on hot-working.

The cost of the low-alloy high-strength steels to the users lies somewhere between the cost of the plain carbon steels and the more usual run of alloy steels. The aggressive promotional work of the large steel companies and some of the large fabricators has brought acceptance in many industrial applications.

New Steels in Mine Cars

An example drawn from the mining industry will at the same time illustrate what has so far been the most important use of these new steels in any field—that is, in car building. In 1937, the Utah Copper Company ordered 250 new 100-ton cars to move ore from Bingham to the concentrators. Cumoloy, a copper-molybdenum low-alloy steel, was specified for the plates, and Corten, containing chromium, silicon, copper, and phosphorus, for the shapes. Without taking full advantage of the high physical properties of these steels, the weight of the car was reduced from 54,800 lb. to 45,700 lb. A single locomotive is now able to haul 50 empty cars on the up-grade, back haul, where formerly the limit was 43. This has greatly increased both the pay load and the tonnage of loaded movements.

The low-alloy high-strength steels have found many other applications where high strength or improved corrosion resistance is of importance. They are being used for all types of transportation equipment, mine cars, trucks, and trailers, as well as for dredges, derricks, mill buildings, mine equipment, stacks, and tanks.

A further increase in strength can be obtained in the copper steels by a low-temperature heat-treatment, known as precipitation hardening. When steels containing more than 0.6 to 0.7 per cent copper are held at temperatures of about 900 to 1,000 deg. F. for some time, a marked increase in tensile strength, yield strength and Brinell hardness, accompanied by a small loss in ductility, occurs. In low-carbon copper-alloy steels the strength may be increased by over 10,000 lb. per square inch by this treatment. With higher-carbon steels and in the presence of other alloying elements the effect referred to above is diminished.

The plain copper-alloy steels containing at least 1 per cent copper can also be heat-treated in the usual way to gain strength with increased hardness. As the strength of steel is increased in this way, the ductility decreases slightly, just as when carbon is raised in the plain carbon steels. This loss in ductility for a given increase in strength is less with the copper steels than with plain carbon steels. On the whole, however, the use of heat-treatments to secure greater strengths is not practiced.

Copper Increases Tensile Strength

In steels containing from 0.20 to 0.40 per cent carbon, an addition of 1 per cent copper will increase the tensile strength about 20,000 lb. per square inch, the yield strength from 15,000 to 20,000 lb. per square inch, and the Brinell hardness about 35

Table II—Mechanical Properties of Plain Copper Cast Steels.*

Chemical Composition Per Cent						Heat Treatment (a)	Mechanical Properties				
C	Mn	Si	P	S	Cu	° F.	Tensile Strength Lb. per Sq. In.	Yield Strength, Lb. per Sq. In.	Elongation, per cent in 2 In.	Reduction of Area per cent	Brinell Hardness
						Fully Annealed					
Low-Carbon Steels											
0.19	0.63	0.33	0.012	0.030	....	1,600	62,000	42,000	36.5	59.8	128
0.16	0.90	0.40	.....	.....	1.15	N + A	73,250	55,250	32.0	59.0	137
0.15	0.60	0.35	.....	.....	1.66	N + A	76,750	60,500	29.0	48.0	152
0.19	0.63	0.40	.....	.....	1.88	N + A	76,250	58,500	31.0	53.0	152
Medium Carbon Steels											
0.31	0.75	0.42	0.029	0.034	....	1,650	77,000	43,500	28.7	44.5	134
0.31	0.75	0.42	0.029	0.034	1.21	1,650	90,000	61,000	24.8	43.6	161
0.31	0.75	0.42	0.029	0.034	1.76	1,650	90,500	58,500	24.5	41.4	159
0.31	0.82	0.44	.....	.....	2.13	1,600	86,750	65,750	25.9	42.8	152
						Normalized					
0.31	0.75	0.42	0.034	0.024	....	1,650	85,500	54,500	29.5	53.4	146
0.31	0.75	0.42	0.034	0.029	1.21	1,650	97,500	68,000	25.5	51.0	170
0.31	0.75	0.42	0.034	0.029	1.76	1,650	114,500	86,000	19.8	42.0	216
						Quenched and Drawn					
Oil-Quenched Steels						Quench Draw					
0.32	0.80	0.40	0.014	0.031	....	1,650 1,200	83,500	53,500	29.0	60.4	...
0.30	0.83	0.39	.....	.....	1.30	1,650 1,200	99,000	70,500	25.0	55.4	...
0.32	1.52	0.40	.....	.....	1.28	1,650 1,200	111,500	94,500	21.0	53.4	...
Water-Quenched Steels											
0.31	0.75	0.42	0.034	0.029	....	1,650 1,200	92,500	66,500	26.0	61.8	164
0.31	0.78	0.36	.....	.....	0.52	1,600 1,200	98,000	69,125	26.2	57.0	183
0.31	0.75	0.42	0.034	0.029	1.21	1,650 1,200	104,500	89,000	20.5	55.6	198
0.31	0.75	0.42	0.034	0.029	1.76	1,650 1,200	113,000	99,000	18.8	46.9	216
0.31	0.75	0.42	0.034	0.029	2.40	1,650 1,200	116,500	105,000	20.0	52.3	222

* Greenridge, C. T. and C. H. Lorig: "Properties of Some Copper-Bearing Cast Steels." A.F.A. Preprint 39-29. May, 1939.
a N + A= 5 hr. at 1,650° F., air cooled, 1,575° F. for 1 hr. furnace cooled.

points, with a decrease in the reduction of area and the elongation of about 3 per cent when heat-treated; that is, normalized or quenched and tempered.

Copper Cast Steels — In the cast steels, copper additions not only raise the strength and corrosion resistance of the finished casting, but in many applications increase the fluidity of the molten metal so that intricate parts or thin sections can be cast more satisfactorily.

The most advantageous copper content in cast steel is from 1 to 2 per cent. Less than 0.5 per cent has little effect, and, although the strength is increased as the copper content is raised, more than 2.0 per cent copper tends to reduce the ductility of the steel.

The mechanical properties of a few typical copper alloy cast steels after different heat-treatments are shown in Table II.

Use of the precipitation-hardening heat-treatment fits in nicely with the production of copper steel castings, as many castings are now given a heat-treatment in addition to the customary annealing or normalizing treatment. The low temperatures used for precipitation hardening are of real advantage when the casting is of intricate shape and when hardening by quenching would introduce warping and unequal strains.

Addition of 1 to 2 per cent copper to an ordinary plain carbon cast steel results in an increase in yield strength of 10,000 to 20,000 lb. per square inch, which may be increased an additional 20,000 lb. per square inch by low-temperature heat-treatment.

In many applications the use of other alloying elements in combination with copper results in greater improvement in properties than can be secured by the use of copper alone. For example, copper-molybdenum steel castings have been used for dredge and mine pumps operating under severe corrosion conditions.

Copper-silicon steel has been used in certain parts of the landing gear of recent Boeing transport planes. The steel contains 0.12 to 0.20 per cent carbon, 1.10 to 1.35 per cent manganese, 1.0 to 1.25 per cent silicon, and 1.50 to 2.00 per cent copper, with low phosphorus and sulphur.[2] A description of the manufacture of these castings and a discussion of the routine tests imposed by the specifications for steel castings for airplanes is given in an article by Finlayson published in the *Aero Digest* for July, 1939.

Copper-alloy steels of this general type have been brought to a high degree of development by the Ford Motor Company. Table III gives the compositions and the corresponding physical properties of a number of copper alloy steels used by this company.

[2] U. S. Patent 2,034,136.

Table III—Composition and Mechanical Properties of Copper-Alloy Cast Steels.*

Abridged

Cast-Steel Analysis Chart

Type	Part	Carbon	Copper	Silicon	Manganese	Chromium	P Max.	S Max.
1	Clutch pedal	0.15–0.35	1.50–2.00	0.60–0.80	0.40–0.60	.....	0.08	0.08
2	Truck ring gears, carburized parts	0.28–0.35	0.50–1.50	0.40 Max	0.30–0.45	0.90–1.20	0.05	0.05
3	Centrifugal castings	0.35–0.40	0.50–1.50	0.40 Max	0.65–0.80	0.90–1.10	0.05	0.05
4	Rear axle housing connecting rods	0.35–0.40	0.50–1.50	0.40 Max	0.70–0.90	.....	0.10	0.08
7	Truck rear axle housing tube	1.35–1.55	.....	0.90–1.10	0.40–0.60	0.08 Max	0.10	0.08
8	Crank shaft bearing sleeve	1.35–1.60	1.50–2.00	0.85–1.10	0.70–0.90	0.40–0.50	0.10	0.08
9	Piston	1.40–1.60	1.00–1.50	0.90–1.10	0.80–1.00	0.08–0.15	0.10	0.08

Physical Properties of Test Bars

Type	Elastic Limit, p. s. i.	Tensile Strength, p. s. i.	Elongation % 2 in.	Brinell Hardness	Heat-Treatment
1	53,800	71,100	18.5	163	Normalize
2	56,500	78,000	16.5	170	(*a*)
3	62,000	86,000	16.0	184	Normalize
4	65,120	90,750	15.2	187	Normalize
4	108,150	128,260	10.0	277	Hardened (*b*)
7	84,000	103,000	9.0	207	Normalize
8	95,080	120,250	6.5	255	(*c*)
9	85,000	104,710	7.5	229	(*c*)
Regular malleable	38,000	52,000	15.7	119	.....
Ford malleable	43,000	60,500	14.0	140	.....
0.30 C Forged steel	60,000	85,000	27.0	165	.....
0.40 C Forged steel	80,000	110,000	20.0	225	.....

* McCarroll, R. H. *Foundry*, Oct. 10, 1938, pp. 30, 72–74.
(*a*) Carburize and direct quench or reheat and oil quench and draw to Rockwell C 58–62. (*b*) Connecting rods, oil quenched and draw. (*c*) 1,650° F. at heat 20 min., air cool to a max. of 1,200° F., reheat to 1,400° F., hold for 1 hour, furnace cool to 1,000° F. Parts to be hardened may be oil-quenched and drawn.

Table IV—Mechanical Properties Copper-Alloy Cast Irons.*

Abridged

Composition of Cast Iron						Mechanical Properties			
							Tensile Strength	Transverse	
C	Si	Mn	S	P	Cu	Brinell Hardness	Lb./Sq. In.*g*	Load *b*	Deflection
3.56	1.10	0.64	0.10	0.15	0.21	205	32,836	2356	0.301
3.47	1.07	0.87	0.10	0.15	0.67	217	35,893	2435	0.238
3.27	1.07	1.15	0.09	0.16	1.06	239	38,900	2550	0.239
2.97	1.50	0.69	0.11	0.13	0.13	225	38,650	2655	0.239
2.88	1.55	0.98	0.11	0.13	1.10	258	44,595	2853	0.226
3.32	2.35	0.69	0.10	0.25	0.19	217	35,026	2323	0.257
3.23	2.28	0.88	0.08	0.25	0.94	241	37,286	2427	0.220

* Schnee, V. H.: "Copper Has Beneficial Effect on Cast Iron Properties." *Foundry*, May, 1937.
(*a*) Transverse bars 1.2-in. diameter tested on 18-in. centers. (*b*) Tensile bars machined from broken transverse bars.

Table V—Specific Applications of Copper-Alloy Cast Irons

Application	T. C.	Si	Mn	Cu	Mo	Cr	V	Ni
Lead pots, Calorizing pots	3.25	1.25	0.70	1.50	....	0.50	....	....
Clutch shell for crawler crane	3.25	2.00	0.70	1.00	0.75	0.20	....	....
Hoist drum	3.25	1.50	0.70	1.50	0.60	....	....	....
Brake drum	3.30	2.00	0.70	1.50	....	0.50	....	....
Brake drum	3.15	1.90	0.65	1.50	....	....	0.10	....
Brake drum	2.90	2.25	0.70	1.20	0.65	....	....	....
Metal molds	3.30	2.20	0.70	1.50	....	....	0.10	....
Sheaves	3.25	1.80	0.70	1.50	....	....	....	....
Sheaves	3.25	2.00	0.70	1.25	0.35	....	....	....
Cylinder block, Cylinder head	3.15	2.00	0.85	0.75	0.30	0.60	....	....
Cylinder block, Cylinder head	3.25	1.90	0.70	0.75	....	....	....	....
Fly-wheels	3.40	1.60	1.25	0.75	....	....	....	....
Sluice gates, Spill valves, Hydraulic nozzles	3.25	1.50	0.80	1.20	0.60	....	....	....
Crankshafts, diesel and gasoline engines	2.80–3.10	2.00–2.25	0.60–0.80	0.10–0.20	.60–1.00	.20 Max	....	1.50–2.00
Cylinder blocks, truck diesel engines	3.15–3.35	2.00–2.25	0.60–0.80	1.00–1.20	1.00–1.10	.70–.90	....	0.10–0.20
Flywheel housing, side rails, steering gradient, farm tractor	3.20–3.40	1.80–2.10	0.60–0.80	0.40–0.60	....	.15–.25	....	....
Main columns, presses	3.10–3.30	1.40–1.60	0.70–0.85	1.00	....	....	....	....

Copper-Alloy Cast Irons — In the past few years the use of copper in cast iron has experienced a large increase. In general, copper increases the fluidity of cast iron and improves its casting qualities. It hardens the matrix, refines the graphite, and closes the grain or "tightens" the iron. Copper also improves the machinability of low-silicon cast irons. The effect of copper on the mechanical properties of cast irons depends on the type of iron and the relative amounts of carbon and silicon present. Table IV lists the mechanical properties of a few typical plain copper-alloy cast irons.

Copper is also used in combination with nickel, chromium, molybdenum,

vanadium, and other alloying elements, and the irons so made have a wide range of properties. Table V lists a number of different compositions that have been found to give satisfactory performance in service.

Copper alloys readily with cast iron. No oxidation losses occur when copper is charged to the cupola. Baled wire and sheets, ingots, and scrap copper can be charged directly to the cupola, and clipped wire or copper shot can be used as additions to the ladle. In practice, the usual copper addition is from 0.5 to 3.0 per cent.

Copper-Molybdenum Alloy

Small amounts of copper, 0.25 to 0.50 per cent, have long been used to improve the resistance of cast-iron pipe to corrosion by hot crude oil, and copper alloy cast-iron pipe is used in handling mine waters. A copper-molybdenum cast iron containing approximately 2.50 per cent carbon, 2.0 per cent silicon, 1.00 per cent copper, and 0.35 per cent molybdenum has been used with success for lock gate valves to resist highly acid water in the Monongahela River. This copper molybdenum cast iron is reported to have the following physical properties: tensile strength 55,000 to 65,000 lb. per square inch, Brinell hardness 220-240.[3]

A proprietary alloy cast iron, known as NiResist, has found wide application for corrosion resistance. This alloy contains from 12 to 15 per cent nickel, 5 to 7 per cent copper, 2 to 3.5 per cent chromium, and about 3.0 per cent carbon and 2.0 per cent silicon. Irons of this type are used for engine parts, chemical equipment, pump casings and impellers, filter grids, gas compressors, condenser parts, electric furnace parts, pipe fittings, and other parts where resistance to corrosion is of primary importance.

The growing use of copper is a typical, if comparatively recent, feature in the development of alloy irons and steels. Producers of nickel, chromium, molybdenum, and vanadium have taken a leading part in iron and steel research for many years, and the results of their efforts are well known. But it is too little appreciated that metallurgical research does not only create new and better materials for manufacture and construction. It often builds important new markets for the products of the mineral industry.

This paper is based largely on reports prepared by members of the staff of Battelle Memorial Institute, where for several years American copper producers have sponsored a research program on the use of copper in iron and steel.

[3] Anonymous: "Reducing Corrosion and Erosion in River Structures." *Metallurgia*, Vol. 18, 1938. Pp. 215-216.

Equipping a Small Gold Mine On the Mother Lode

Total cost, including construction work, for mine, mill, and miscellaneous, was $403.95 per ton of daily capacity

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DURING the latter part of 1938, in connection with the design and construction of a treatment plant for a gold mine in the southern part of the Mother Lode district in California, I compiled the cost data here presented. The tabulations given represent costs actually secured during the construction of the plant. The property is situated in the foothills of the Sierra Nevada Range at an elevation of 2,200 ft. Topography of the surrounding country is quite rough, with the nearest railroad point some 35 miles distant. Though 25 miles of the road are paved, the last 10 miles are unpaved and rough, with steep grades. The mine had been under development for several years, and was opened up by two adit levels. Sufficient housing facilities for a small working crew were available, but there was only a small amount of equipment. Also, there was no electric power, and to overcome this deficiency it was necessary to provide diesel and gas-engine power.

After all metallurgical tests of the ore had been completed, the accompanying flowsheet was adopted. Search for available used equipment, which could be fitted into the different departments of the mill, followed. As a result, the complete mining and milling machinery at a gold mine in Oregon was bought, disassembled, and shipped to the mine in California. These units were supplemented by the purchase of additional new equipment. Save for a 14-in. belt conveyor, 33 ft. 6 in. between centers and on an inclination of 19 deg., leading from the crusher discharge and undersize hopper of the grizzly to the fine-ore bin, the design of the mill provided for a complete gravity flow.

Coarse-ore storage consisted of a wooden bin with a sloping bottom capable of holding 100 tons, the inside dimensions of which were 15 ft. long, 12 ft. wide, and 17 ft. deep at the front of the bin. A rectangular steel bin, 10x10x8 ft., made from ¼-in. plate and subsequently deepened to 16 ft. by cribbed construction of laminated 2x4-in. timber built up on top of the bin, provided storage for about 80 tons of fine ore. The mill building proper was 71 ft. 6 in. long and 30 ft. 8 in. wide, and contained four separate floors—namely, a ball-mill floor, 30 ft. 8 in. by 30 ft. 3 in.; flotation floor, 30 ft. 8 in. by 11 ft.; concentrator floor, 30 ft. 8 in. by 15 ft. 3 in.; and a thickener floor 30 ft. 8 in. by 15 ft. Vertical distance between the ball mill and flotation, flotation and concentrator, concentrator and thickener floors was 5 ft., 3 ft. 4 in., and 10 ft. respectively. Concrete walls 8 to 12 in. thick were provided between the floors and at the lower end of the building, with the thickener floor being kept at truck height above the road at the lower end of the mill to facilitate loading of concentrates.

Used equipment purchased included steel frames, made from channels, angles, and I-beams, for the ball mill and concentrator floors, and all necessary supports for machines and line shaftings, and floors. Employment of this material obviated the use of considerable concrete for foundations. The thickener floor was of concrete construction, and 2x6-in. t. & g. No. 1 Douglas fir car siding was used for that of the other floors, which involved 4,320 ft. b.m., costing $39.93 per 1,000 ft. b.m. at point of railroad delivery. The main power plant, consisting of an 80-hp. Atlas-Imperial, four-cylinder diesel engine and auxil-

The amalgamation-flotation plant erected and equipped by the author on the Mother Lode

iaries, was housed in an annex to the mill building proper at the level of the concentrating floor. It also contained the clean-up room, and measured 23x12 ft., with an average roof height of 10½ ft. All units in the mill building were driven by belt through three line shafts actuated by the diesel engine. Lighting was furnished by a 7-kw. d.c. generator belted to the line shaft, and a 1,500-watt Kohler automatic light standby unit when the mill was not in operation. A 15-hp. Type Z, Fairbanks-Morse gas engine provided power for the crusher, which, with the conveyor, was housed outside of the mill building under a shed roof. At the level of the ball-mill floor there was a shed annex containing the mine compressor, and ball and reagent storage.

Solid Rock Excavation

The mill site was adjacent to the lower tunnel of the mine, the natural ground slope being about 20 deg. No excessive excavation was necessary. The coarse-ore bin was installed so as to allow a tramming grade from the mouth of the lower tunnel 110 ft. distant to the top of the bin. Horizontal distance from the front of the bin to the upper end of the mill building was 31½ ft., and the top of the bin was 42 ft. vertically above the ball-mill floor. Total difference in elevation between the top of the bin and the thickener or lowest floor of the mill building was 60 ft. 4 in. Ore bins, crusher, conveyor, and long dimension of the mill were all in a straight line. A part of the mill site was occupied by an old five-stamp mill which had to be removed before construction for new installations could be started.

Excavation was almost entirely in solid rock composed of fairly soft slate. The work was done with a bulldozer, assisted by drilling and blasting, and finished up by hand. The foundations for the ore bin and conveyor were excavated entirely by hand. A total of 962 cu.yd. of excavating was done at an average cost of $1.02 per cubic yard. All concrete was of a 1:2:4 mix. Cement was 78c. per sack delivered, and sand and gravel were hauled a distance of 12 miles and cost $3.25 per cubic yard delivered. Some 53 cu. yd. of concrete were poured at an average cost of $23.88 per cubic yard.

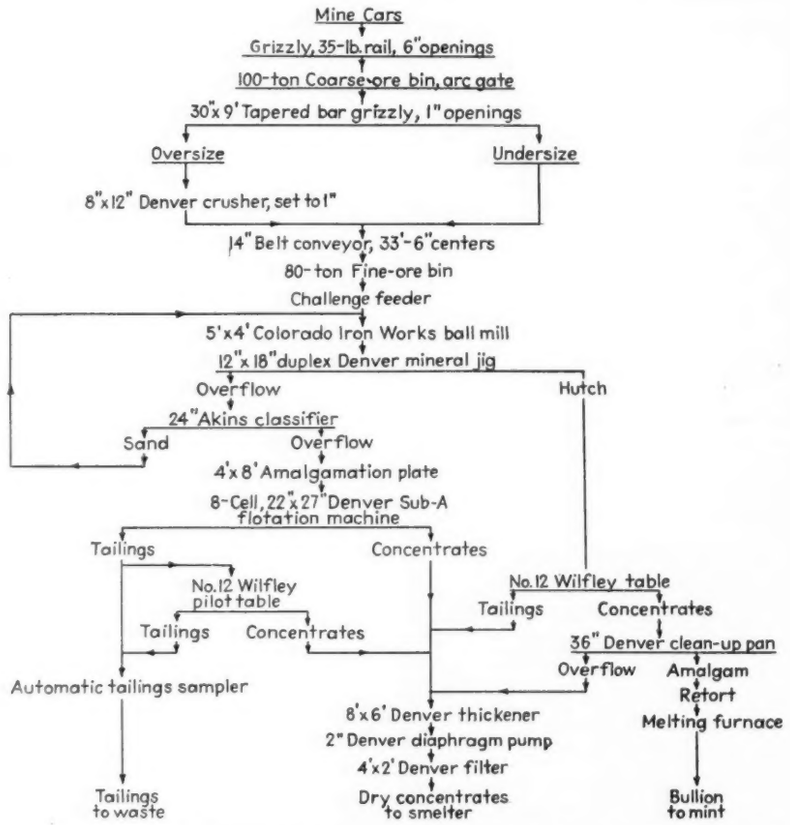
The frame of the mill building was constructed entirely of No. 2 common rough Douglas fir timber, about 18,045 ft. b.m. being used, and costing $25.43 per 1,000 ft. b.m. at point of railroad delivery. Posts were 8x8 in. at 10-ft. centers set on the concrete walls or on piers with no trusses. Overhead beams and joists were 8x8 in. and 6x8 in. built up by laminating 2x8-in. timber. Rafters and studding were 2x6 in., and roof and walls were covered with 26-gage galvanized corrugated sheets nailed to rafters and studding. A total of 9,400 lb. of sheets was used, costing $4.75 per 100 lb. delivered. The roof pitch was 1:3, and the total roof length 77 ft. 6 in. Average roof height was 16½ ft. The total volume and total area of the building were 39,150 cu.ft. and 2,476 sq.ft. respectively, the cost being $0.059 per cubic foot and $0.93 per square foot.

Cost of Equipping a Small California Gold Mine

Cost of used mill equipment and diesel engine				$7,448.00		
Disassembling and loading				715.64		
Cost of new mill equipment				2,299.51		
Total cost of mill equipment and diesel engine						10,463.15
(Cost of mill equipment if all new				$13,589.51		
Cost of diesel engine if new				4,800.00		
Total cost of equipment if all new)				$18,389.51		
Freight on equipment				$1,415.83		
Hauling equipment				385.74		
Total freight and hauling					$1,801.57	
Mill Construction:	Labor	Material and Supplies	Other Expenses			
Wrecking and clearing	$76.00	.....	.....	$76.00		
Excavating	460.26	$119.83	$272.50	852.59		
Concrete	571.26	598.14	.....	1,169.40		
Building, fine ore bin and conveyor	911.06	1,346.93	52.55	2,310.54		
Erecting machinery and repairs	1,332.20	220.39	136.46	1,689.05		
Piping and launders	335.15	251.64	.....	586.79		
Wiring	134.61	30.89	.....	165.50		
Adjusting machinery	369.26	15.00	.....	384.26		
Total mill construction					7,234.13	
Coarse ore bin construction:						
Excavating	$128.90	.....	.....	$128.90		
Concrete	54.47	$42.32	.....	96.79		
Erecting	189.77	348.65	$76.67	615.09		
Total coarse ore bin construction					840.78	
Roads construction	$213.38	.....	$375.42	.....	588.80	
Oil storage construction	97.63	.....	42.00	.....	139.63	
Auto and truck repairs and maintenance	.....	.....	.....	.....	163.44	
General expense, compensation insurance, office expense, engineering and management	.....	.....	.....	.....	3,005.55	
Total cost of construction, freight and hauling						13,773.90
Total cost of mill, ore bins, roads and oil storage						$24,237.05
Mining equipment and miscellaneous construction and equipment:						
Cost of used mining equipment				$2,552.00		
Disassembling and loading				89.45		
Reconditioning mining equipment				438.27		
Cost of truck and miscellaneous equipment				521.28		
Cost of new slusher equipment				771.07		
Total cost of mining and miscellaneous equipment (Total cost of equipment, if all new, $6,725.35)					$4,372.07	
Freight on equipment				$158.10		
Hauling equipment				48.22		
Total freight and hauling					206.32	
	Labor	Material				
Slusher construction	$209.49	.....	.....	.....	209.49	
Miscellaneous construction	423.25	$364.31	.....	.....	787.56	
Total cost of mining equipment and miscellaneous construction and equipment						5,575.44
Total cost of all construction and equipment						$29,812.49

The design of the coarse-ore bin provided for four bents of 10x10-in. posts and 10x14-in. floor beams with eight tie rods of 1⅛-in. round mild steel. The bin bottom was covered with 4x12-in. planking, and the sides and ends with 3x12-in. planking. Construction of the bin required 9,007 ft. b.m. of No. 2 common rough Douglas fir timber, costing $25.43 per 1,000 ft. b.m. at railroad delivery point. Labor cost of erecting this timber was $21.08 per 1,000 ft. b.m., and the total cost of the bin was $8.41 per ton capacity. Because of bedrock conditions and to avoid excessive excavation, the front posts and floor beams were supported on a concrete wall extending the length of the bin, with short buttresses at each bent. Only enough excavating was done below the bin to clear the under side of the inclined floor beams.

To secure access to the mill by truck, some 900 ft. of new road were constructed and branch roads connected with each floor of the mill, permitting unloading of equipment at any point desired. Two miles of road leading to the mine also were repaired. As it was desired first to mill accumulated dump ore from development lying at the mouth of the upper tunnel, a slusher-scraper outfit was designed and installed to convey the material to the coarse-ore bin. This arrangement consisted of a Hesse-Ersted double-drum hoist chain-driven by a 12-15 hp. LeRoi, four-cylinder gas engine, both mounted on steel skids, and a 42-in. hoe-type scraper attached to 1,000 ft. of ½-in. plow-steel rope. The ore was scraped into a 15-ton loading hopper fitted with a chute for loading mine cars on the track leading from the lower tunnel to the coarse-ore bin. Storage tanks with a capacity of 5,000 gal. of diesel oil and 2,000 gal. of gasoline were erected at a point 500 ft. from the mill to avoid fire hazard. Connection with the mill building was made by ½-in. pipe lines. Miscellaneous construction involved the erection of a 220-cu.ft. gasoline-driven air compressor, sample-grinding equipment, a water supply, and sundry repairs to old buildings.



Flowsheet of the amalgamation and flotation plant installed at the property on the Mother Lode, 25 miles from the railroad

The construction work described was completed in 93 days, or a total of 1,064 shifts. Number of men varied from 3 to 13, the average being 11, with skilled labor being paid $7 to $10 per day, and unskilled labor $4 to $4.50 per day. The total cost of the mill, power plant, ore bins, roads, and fuel storage as constructed and equipped, together with all overhead, was $24,237.05, or $403.95 per ton daily capacity. If all new equipment had been used, the cost would have been $32,163.41, or $536.05 per ton daily capacity. Total cost of all construction and equipment for mill, mine, and miscellaneous, together with all overhead, was $29,812.49, or $496.87 per ton of daily capacity; $40,092.13, or $668.20 per ton daily capacity, would have been expended if new equipment had been used exclusively. A detailed tabulation of all costs incurred during construction is given in the table on page 47.

▼ ▼ ▼

Use of Corduroy in Saving Gold

INVESTIGATIONS by the Metallurgical Division of the Bureau of Mines indicate that corduroy blankets, used with or without a trap or jig in the mill classifier circuit, often are effective in concentrating gold and sulphides, especially if the gold does not amalgamate readily and if not enough sulphides are present to warrant the use of a shaking table, flotation cells, or cyanide plant. A summary of these investigations is contained in the Bureau of Mines Information Circular 7085 by M. W. von Bernewitz. Small mine operators interested in inexpensive equipment may find that a corduroy table will give good recovery of gold.

The corduroy from which wearing apparel is made is unsuitable for gold saving, as that weave has narrow, closely spaced ribs and the fibers or threads are not cut or free, as they are in milling corduroy. The high side of the rib should always be laid toward the pulp flow. For the average run of siliceous gold ores containing up to, say, 5 per cent of sulphides, corduroy tables are set at a slope of 1½ in. per ft.; the range is 1⅜ in. to 1⅞ in. If copper plates are used at a mine, these may be removed and the corduroy laid on the tables, which should have the proper slope. In amalgamating practice the pulp flows over the copper plates as a series of gentle, shallow waves to enable the gold to have contact with the mercury-coated surface; but a heavy flow does not prevent corduroy from catching the gold and sulphides. Corduroy, however, must be washed frequently so that gold and sulphides do not accumulate to such depth that the ribs are buried and the riffling action stops. Unclassified and fairly coarse pulp may be run over corduroy. To determine whether free gold escapes from flotation cells, corduroy has been used, and it has been found that the use of blankets or shaking tables is recommended for catching any such elusive gold.

Information on plants using corduroy in the United States and other parts of the world is included in the circular and it serves as a guide for anyone planning to use corduroy.

Mechanics of Vein Formation

In the Northern Half of the Baguio District

PART II

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CONCLUDING his geological analysis of the Baguio district, on the Island of Luzon, in the Philippines, the author herein sets forth a study of mineralization, theoretical ground movement, and depth of mineralization.

Mineralization — A study of the mineralization with respect to relative ages of the various vein systems at Baguio Gold indicates that there was a definite sequence in which each of the various minerals appeared. Though all stages of the mineralization are probably not represented on this property, available evidence fairly well represents the general trend. Calcite was the first mineral to appear. As the ore magma became less basic, the percentage of calcite decreased, with a corresponding increase in the quartz content. High gold values are associated with the early quartz surges. Traces of galena, chalcopyrite, and sphalerite are represented in this period. Pyrite and marcasite appeared in the later stages of the quartz surge; they are likewise primary constituents of the intrusives. The dying stages of mineralization are characterized by almost complete quartz filling, which became increasingly barren as the surge died out.

The relation of the gypsum and anhydrite to the ore deposits is a matter of speculation involving their origin. Three possibilities exist:

1. That these minerals represent the dying phases of the primary mineralization.

2. That they are secondary minerals formed in the zone of oxidation by the reaction of the primary calcite mineralization on the ferrous sulphate derived from oxidation of the pyrite and marcasite.

3. That they are a result of intermingling of descending waters containing calcium carbonate with the final surges of the mineralizing solutions, therefore involving the same equation of reaction as in (2).

Under Theory (1), differentiation of the magma must have been responsible for the change in character of the mineralizing solutions from a basic nature during the early calcite stage to acidic during the quartz surge, then back to basic during the gypsum and anhydrite dying phases. It is difficult to find a reason for the mineralizing solutions suddenly reversing their trend of increasing acidity to accommodate the anhydrite mineralization. A study of the local geology provides evidence that there has been no reversal in the natural basic to acidic sequence in differentiation of the intrusives. The occurrence of the minerals has no definite relation to the sequence of mineralization of any of the Baguio Gold vein systems, or to the lateral zoning characteristic of the latest veins to form. If these minerals represented the dying phases of the primary mineralization we would expect the low-grade quartz mineralization to grade into anhydrite as the 2 Vein-Little Corporal Vein type fractures progressed to the southwest. Such, however, is not the fact.

Under Theory (2), the minerals are secondary in origin, formed from reaction of primary calcite mineralization with ferrous sulphate derived from the oxidation of pyrite and marcasite. The calcite may have been in solution as calcium carbonate or still in the solid form at the time of its reaction with the ferrous sulphate. An examination of specimens from the 3 Vein shows gypsum being formed around the margins of calcite chunks contained within the gouge. The mine water at present contains an abundance of calcium sulphate derived from the same reaction.

The accompanying table shows the results of chemical analysis of mine-water samples taken at various locations on the property. Sample A, from one of the upper levels of the mine, shows the relation between the $CaSO_4$ and $CaCO_3$ to be 62.281 grains per United States gallon to 5.304 grains per gallon. Sample B, from the drain tunnel, shows 70.115 grains per gallon $CaSO_4$ as compared to 62.281 grains per gallon from the upper levels. The results show an increase in $CaSO_4$ content as the waters percolate downward through the primary calcite mineralization. Sample C is taken from an exploration crosscut at a considerable distance from the ore zones. The 22.198 grains per gallon $CaSO_4$ content is explained by the smaller proportion of calcite in the vicinity.

Heavily shattered areas in the path of ground movement (therefore a part of the district fracture pattern) might readily have served as reservoir rocks for similar ground waters during the period following mineralization. Deposition of gypsum and anhydrite would result from increased concentration. Subsidence during the Pliocene might well have exposed the gypsum to the action of the sea water, with the resulting formation of anhydrite.

Theory (3) has considerable merit. Under this assumption, the natural basic to acidic trend of mineralization is substantiated. Early calcite mineralization followed by high gold-quartz surges gave way to increasingly lower-grade quartz deposition. Pyrite and marcasite were associated with the late stages of the quartz surge. The ascending solutions, therefore, contained the minerals necessary for the production of ferrous sulphate; the descending solutions were capable of supplying the calcium carbonate in solution from the calcite mineralization; the natural basic to acidic sequence of mineralization and differentiation has not been interfered with. Lateral zoning, expected when considering the gypsum and anhydrite as primary mineralization, would not be expected under this theory. Anhydrite should therefore be expected in those locations which satisfy the following conditions:

(a) There must be a source of calcium carbonate.

(b) There must be an ascending source of ferrous sulphate.

(c) The fracture containing the anhydrite must be properly oriented to permit its reopening by a recurrence of the stresses which caused its formation, or must represent the late stages of fracturing as indicated in the paragraph on theoretical ground movement.

Part of the ferrous sulphate has been supplied by descending waters without regard to ascending solutions, as indicated by direct evidence in (2). I therefore prefer to consider the minerals in question as having been formed by both methods (2) and (3) involving a secondary reaction.

Theoretical Ground Movement—Fig. 5 shows the dip, strike, and relative position of many of the known veins in the north half of the Baguio district. The dotted line of the figure divides the area theoretically into

an active block on the right and a passive block on the left. For purposes of illustration, let us consider this line as that of a warped rim of a badly battered basin within which rests the active block. Local depressions in the rim occur in the path of ground movement. Strain ellipses for east-west compression have been chosen which correspond as closely as possible with the actual dip and strike of the structures and placed in the area which each represents. The inclination of the sides and bottom of the basin are inferred from a study of the strain ellipses of the figure. General trends are indicated; detailed mapping would be required for a complete picture. The plane containing the axis of elongation and the axis of greatest compression lies within the rim or bottom of the basin at the location represented by the position of the strain ellipse under consideration. The inclination of the plane of relief is written adjacent to the ellipse to which it refers. Beginning with strain ellipse *B*, easiest relief is up 30 deg. to the south. The same slope continues as we pass ellipse *A*, higher up on the rim. Continuing in the same direction we pass over the dotted line into the passive block. Easiest relief is horizontal at ellipse *K*, located on the border between the active and passive block. Strain ellipse *C* is similar to ellipse *B*. Continuing down the side of the basin we cross the 440 F. W. Vein system and start up a 15-deg. slope represented by ellipse *D*. Passing northward into Baguio Gold property, the deepest portion of the basin roughly parallels the andesite-sedimentary contact. At ellipse *F* and *G* the basin slopes upward 15 deg. to the north. The slope steepens to 30 deg. N. in the vicinity of ellipse *H*, between the Little Corporal Vein and the 2 Vein, and straightens up to 55 deg. to the north as we pass over the rim of the basin into the passive block represented by ellipse *I*.

Let us compare the theoretical position of fracture planes with the direction and dip of known veins in the figure. Consider first strain ellipse *A* between the Keystone and Ukab veins. Fig. 3C applies if we revolve it 180 deg. to correct for elongation being up to the south rather than up to the north. Two sets of shear planes should form, one striking N. 51¼ deg. W. and dipping 65½ deg. S. W. and the other striking N. 51¼ deg. E. and dipping 65½ deg. S. E. Tension fractures should strike east-west and dip 60 deg. S., provided they have not been distorted by later rotation. The southeast extension of the Keystone lines up well in both strike and dip with the theoretical. The N. 51¼ deg. E. set evidently has not formed. The Bua Vein is oriented properly for a tension fracture, which well accords with the facts.

Let us consider the 3 Vein East shear system and the 3 Vein West tension systems as the first known deformations in the north half of the Baugio district. Mineralization, and other evidence previously offered, establish that they are the first known veins to form at Baguio Gold. Continued application of east-west compression would cause the footwall of the 3 Vein shear system to move to the southwest. (Which accords with the facts.) With the entire active block Fig. 5 taking part in this rotation about an axis somewhere near the southeast corner of the figure, and the passive block resisting this movement, deformation would result, with fracture orientation controlled by the relative strengths of the rocks under stress, as well as the direction and magnitude of the force applied. The theoretical basin shape referred to should be considered as a warped surface marking the transition phase between the zone of fracture and the zone of flow. Below the transition phase the ground may be considered passive. Depth of ore deposition tends to approach, but seldom reaches, this limit.

Continued counterclockwise rotation on the 3 Vein shear system would favor formation of all similarly oriented veins at the greatest distance from the axis of rotation. The northwest system, in the Baguio Gold area —exemplified by the 2A Vein West, 6 Vein F.W. and H.W. Split, and Leonora Vein—would be formed at locations where resistance (in this case Baguio Gold diorite) opposed the rotation. The outside edges of the active block rotate further than the area near the axis of rotation. Therefore, the northwest ends of the 2A Vein, 6 Vein F.W. and H.W. Split, and the Leonora Vein, have been rotated out of their theoretical position in the strain ellipse. This rotation has been as much as 30 deg. in the 2A Vein. As we move nearer the axis of rotation the moment arm becomes less; consequently it becomes increasingly difficult for the northeast shear set to form. The 64 Vein and Antamok Central Vein have been the last known veins of this type to form in the active block.

Failure on the 440 F.W. Vein system and the segment of the Keystone Vein system in the vicinity of the Bua took place properly oriented for east-west compression and were rotated clockwise by continued deformation along Baguio Gold's northeast shear system.

The general trend of ground movement as indicated by the foregoing discussion is shown by the path of arrows on the figure. The passive block resisted this movement and opposed the counterclockwise rotation. The opposing tendency is well illustrated by the manner in which the 3 Vein tension system was formed. Refer to strain ellipse "I," which lies within the passive block. Counterclockwise rotation of the active block was opposed by friction in the passive block. Consider the active area as a pinion meshing with a large gear represented by the passive block. With east-west compression the motive force operating the pinion, the gear would move clockwise. Strain ellipse "I" has likewise been rotated in a clockwise direction.

Theory indicates that the Bungalo Vein, Broadway Vein, and Lost Herd Vein have formed as tension openings in the passive block which resisted the general trend in ground movement. It is possible to conclude that the active block is an area of increasing size; hence the passive area of decreasing magnitude. It would not be surprising, therefore, to find late stages of ground movement and mineralization represented in the portion of the passive area enveloped by the increasing active area in the path of ground movement.

Depth of Ore Deposition—The depth of ore deposition is a matter of considerable interest to operators in this district. Though it would be extreme folly to make any definite statement of the possibilities of ore at depth in a given area without first mapping in detail and studying the fractures, a study of the foregoing ground movement offers valuable clews as to the relative depths to expect mineralization, and furnishes valuable information as to the proper elevation in which to explore unknown areas within the active block. Fracturing and ore deposition in the passive block are beyond the present scope of this paper.

The theoretical basin shape, previously referred to, marks the lower limit of fractures. The actual detailed shape of the basin could be approached only after detailed study of every exposure available. Since ore deposition tends to approach, but seldom ever reaches, this limit, we can consider the lower limit of ore deposition as marked by a smaller, similarly shaped and similarly oriented basin suspended within the first. If we assume that the lower limit of ore deposition has been reached by

	Sample A From Upper Level, Grains per U. S. Gallon	Sample B From Drain Tunnel. Grains per Gallon	Sample C From Exploration Cross-cut. Grains per Gallon
Silica	0.70	1.810	3.45
Fe and Al oxides	0.116	0.116	0.09
Calcium carbonate	5.304	6.260	6.425
Calcium sulphate	62.281	70.115	22.198
Magnesium carbonate	1.956	1.990	1.750

the mine workings on the 440 F.W. Vein system, we can establish this lower limit as a position at which to suspend the smaller basin. As we pass north into Baguio Gold property, the deepest part of the basin roughly follows the andesite-sedimentary contact. To the southwest of the contact, in the vicinity of ellpises *F* and *G*, we would expect the lower limit of ore deposition to slope upward to the north at an angle of 15 deg. In the vicinity of ellipse *H*, easiest relief is up from 15 deg. to 30 deg. to the north. The lower limit of ore deposition should (and does) follow the same trend. North of the 3 Vein we are in the passive block.

Passing south from the 440 F.W. Vein system to the Keystone Vein system via ellipse *B*, ore deposition should bottom at a correspondingly higher elevation than that of the 440 F.W. Vein system. Proceeding south from the Keystone to the Ukab, elongation is still upward 30 deg. to the south. Ore deposition on the Ukab should bottom at a correspondingly higher elevation than on the Keystone system. Continuing south we pass over the rim of the basin where vein formation is due to transmission of forces through the buttress rather than regional ground movement.

According to all information available to me, the foregoing pure theory accords well with the facts. Due to the local nature of the field-work, all statements regarding areas outside the Baguio Gold property limits are merely matter of personal opinion based upon a study of known facts at Baguio Gold. There are undoubtedly other phases of fracturing and mineralization unknown to me. Most geologic proofs are no more than well-founded opinions, and this article is no exception; it is offered at its face value.

In conclusion I wish to thank P. A. Meyer, president, and W. T. Graham, general superintendent of the Baguio Gold Mining Company, for permission to publish this article; also to John F. Patton, of the engineering staff, for valuable comment and criticism. I also wish to express my appreciation for the cooperation shown by the management and geology department of the Benguet Consolidated Mining Company, and to A. F. Duggleby, its vice-president, for permission to publish information relating to the Antamok vein systems.

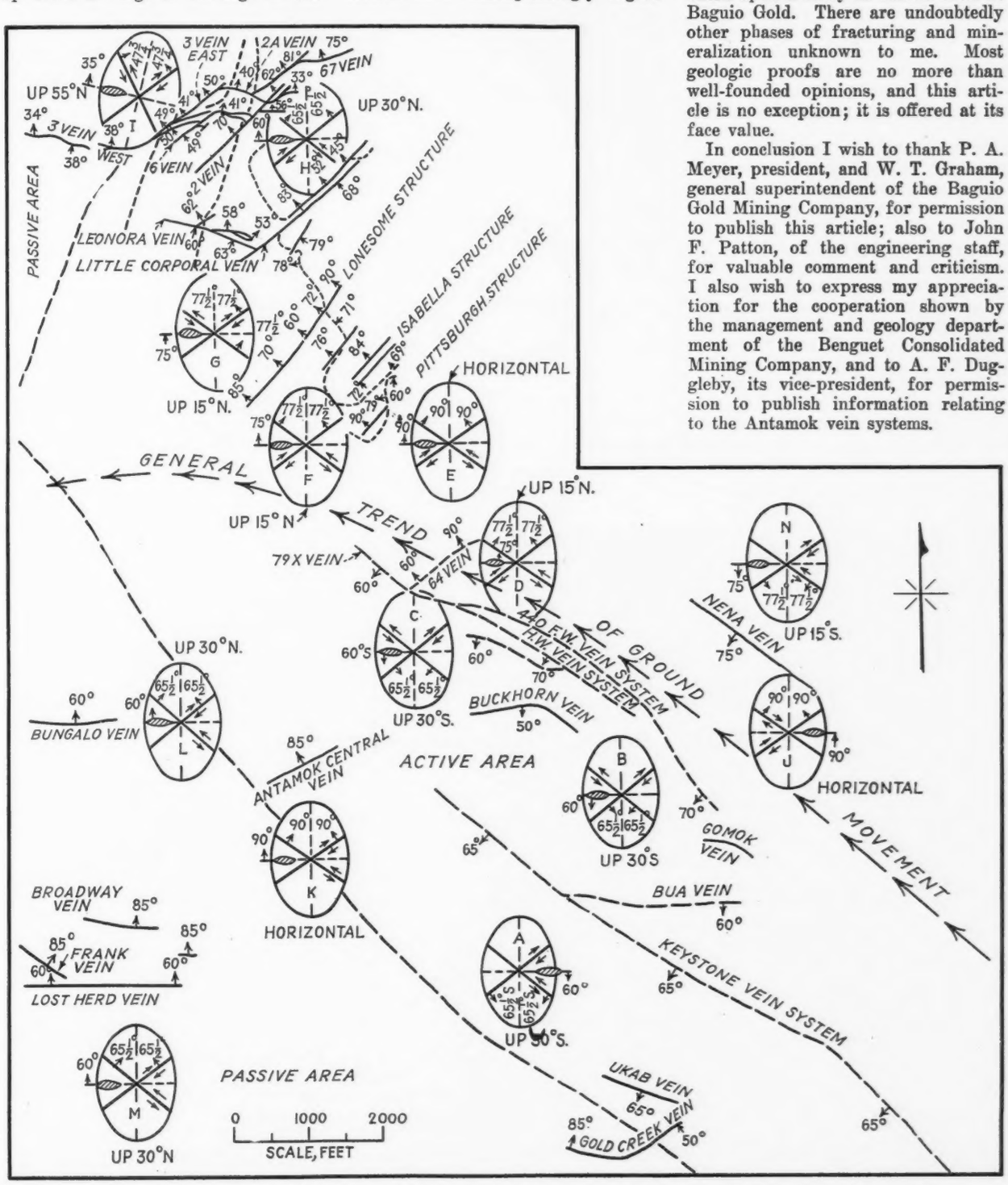


Fig. 5 . . . Vein systems in north half of Baguio district with horizontal sections illustrating the theoretical ground movements

Motion Pictures Help Educate The Public as to Mining

A library of over 3,000 reels, intended for public use, has been built up in the last twenty years

John W. Finch
Director, Bureau of Mines
Washington, D. C.

A REMARKABLE EXAMPLE of practical accomplishment in the establishment of better public relations, achieved as the result of close cooperation between industry and Government, is afforded by the great motion-picture library dealing with mines and minerals, which has been built up by the Bureau of Mines of the Department of the Interior, during the past two decades. That the public is also cooperating is evidenced by the fact that the films were shown last year on 94,369 occasions to an attendance of approximately nine and a half million Americans. This great library is comprised of 3,399 reels from more than 60 different films, which present the story of the production, treatment, transportation, and utilization of the more important minerals, in a vivid and impressive manner, which no prosy textbook or wordy lecture can ever hope to equal.

About twenty years ago the Bureau of Mines undertook the work of establishing a library of motion-picture films which should picturize and popularize for the benefit of all of the people the colorful, dramatic stories that are interwoven with the development of the great industries that are producing the numerous minerals on which the comfort and welfare of the nation depends. Having no funds for the launching of this program, the Bureau considered it advisable to ask the mineral industries to defray all costs incident to the production of the films and of providing copies for distribution by the Government.

To make possible the building up of this splendid film library, the mineral industries of the United States, over a period of approximately twenty years, have appropriated a sum in excess of a million dollars. No industry has ever shown its willingness to cooperate with a Government agency in a more admirable manner.

The occurrence of a series of shocking coal-mine disasters in the Appalachian region was largely responsible for the establishment of the Bureau of Mines on July 1, 1910. The nation demanded that something be done by the Federal Government to prevent, or at least to minimize, these disasters. Naturally the first concern of the newly established Bureau was the problem of safety in mining.

The subject of safety has, therefore, been emphasized in the Bureau's motion-picture program. Some of the films are devoted entirely to safety, and in many others, safety has been given a considerable degree of attention. The Bureau has found the motion-picture film to be an excellent medium for advancing the safety education of the miner, and the exhibition of these films before thousands of miners annually has brought home to them the principles of first-aid and safety in mining in the most effective manner possible.

The Bureau's films illustrate operations and processes such as excavating, dredging, drilling, blasting, crushing, grinding, smelting, welding, and polishing. They show how the processed material is finally worked up into the finished articles of commerce.

About a dozen of the films relate to petroleum and petroleum products. They show how oil is produced, not only in the United States but also in many foreign countries. They visualize the history of the oil industry, the refining of petroleum, the making of gasoline and lubricating oil.

The dramatic stories of the important metals such as copper, lead, nickel, steel, and silver are presented. Several of the important non-metallic minerals, such as sulphur, asbestos, cement, abrasive materials, and fireclay, are represented in the collection.

A number of the films deal with automobiles, the automobile engine, automobile engine fuels, and lubrication. One film covers the subject of safety glass.

Although the hundreds of commercial minerals are vital to the welfare of every inhabitant of the country, and in fact essential to the very existence of the nation, the average American is none too well informed as to where minerals come from, what they are like, how they are mined and processed, and how they enter into the construction of buildings and highways, the fabrication of means of transportation and communication, and the making of thousands of everyday articles and necessities. There is hardly a better way of making all of this understandable to the millions of Americans than through the medium of the motion-picture film.

It was a not-uncommon occurrence in the past to see large bodies of students, accompanied by instructors, visiting mines and plants to obtain detailed information regarding their operations. Now the very atmosphere of our great steel mills, quarries, mines, and factories has been captured and brought right into the classroom in the form of carefully prepared films, which present all important facts with a clarity and thoroughness quite impossible of attainment even through personal inspection. Young America, thanks to the educational motion-picture film, is learning just how minerals are wrested from the earth, dressed up, and made to serve mankind.

The relationship between the Bureau of Mines and mining and oil companies, manufacturers, trade associations, and individuals who have sponsored these films has engendered a spirit of cooperation that has been of great assistance to the Bureau in furthering its work in the fields of technologic research and health and safety. When funds have been appropriated by the sponsor of the film

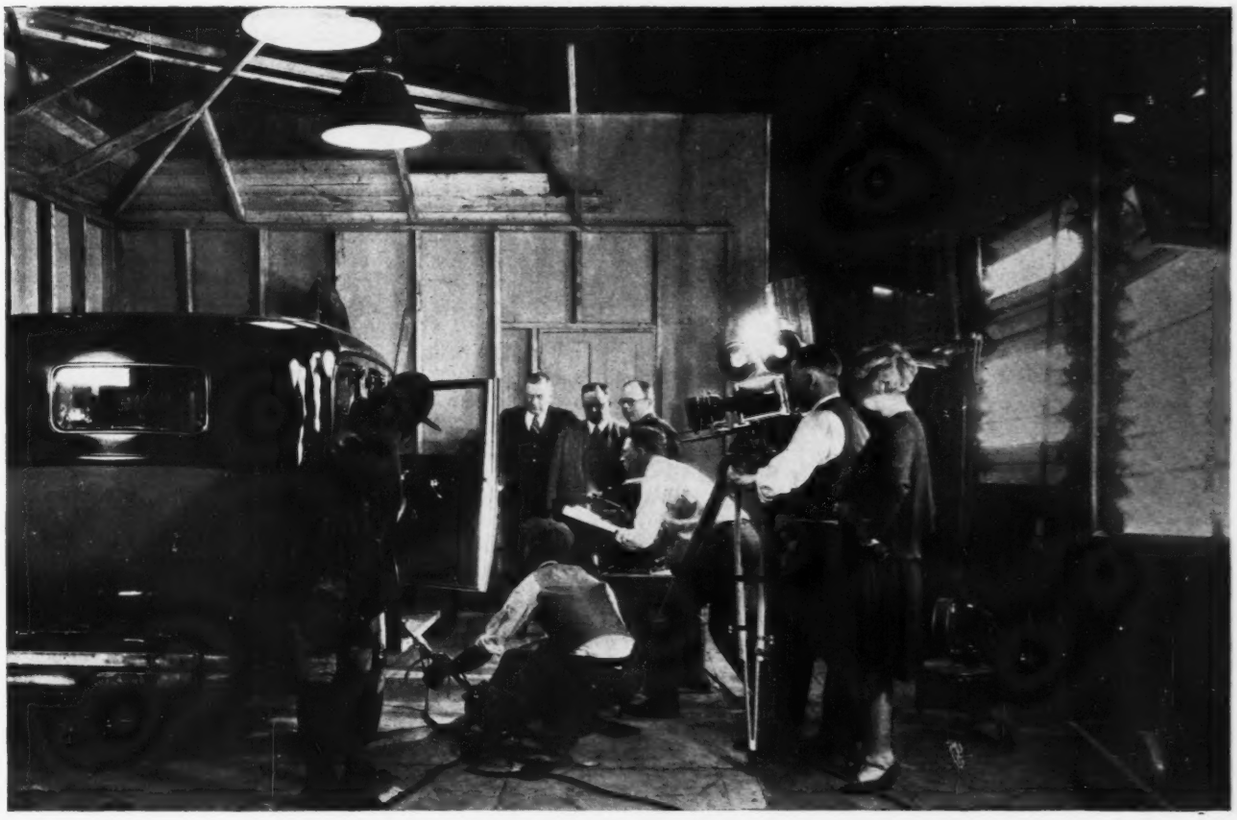
Asbestos operations in Arizona are being filmed in the course of preparing a Bureau of Mines motion picture dealing with this mineral

to be made, Bureau specialists whose work is closely related to the subject are consulted in the preparation of the scenario. In many instances they accompany the camera crew to location and personally assist in the supervision of the scenes photographed, so as to insure technical accuracy.

The matter of close relations with the public, the problem of bringing the millions of Americans to a better understanding of industrial processes and activities, is one in which the executive of every industry is vitally interested. During the past year large sums have been expended by many industries in the preparation of motion-picture films designed to furnish the public, and especially the student body of our nation, with authentic facts regarding the manufacture, distribution, and utilization of their products. The educational motion-picture films of the Bureau of Mines are especially effective for the reason that industry and Government have cooperated in their making. The public, realizing that a Government-supervised film must be authentic and free from propaganda, has accepted these films in good faith and evidenced its interest by annual attendances running into the millions.

The United States today is striving to achieve the utmost efficiency in all the operations involved in the production, distribution, and utilization of commodities. This effort is a part of the general program designed to conserve our natural resources so that the generations to come may also share substantially in the benefits to be derived from the vast mineral wealth that nature bestowed upon our land. No Government agency is more vitally concerned in this program than is the Bureau of Mines, whose program of research, extending over a period of 28 years, has helped greatly in conserving our mineral resources through the attainment of better methods of mining, milling, processing, and refining.

It is the hope of the Bureau of Mines that the mineral industries will make the freest use of the films already prepared, and that they will continue to cooperate in the building up of this great collection of motion-picture films. Thus they may assist in giving to the American people a clearer and more comprehensive picture of the operations of the great commercial enterprises that provide the mineral materials essential to the greatness and prosperity of America.



Shooting scenes for the Bureau of Mines motion picture "Carbon Dioxide"

Model Shaft Aids in Studying Air Flow

Tests indicate that with two-compartment opening, timbered with square-sets, resistance can be reduced by placing triangular blocks on upstream faces of dividers, wall, and end plates

R. R. Krum, L. G. R. Crouch, and K. Hayes
Research Students

R. S. Lewis
Professor of Mining, University of Utah, Salt Lake City, Utah

IN A FORMER STUDY of the flow of air[1], the model used was a drift, 5x7 in. in the clear, timbered with 1-in. sets. Built on a 1/12th scale, the model represented a drift 5x7 ft. in the clear, timbered with 12-in. three-piece sets. A study of pressure losses over a 20-ft. length was made, using round and then square timbers. It was found that at a spacing of approximately 6¾ in. both forms of timbering gave the same resistance to the flow of air. At spacings less than this, square timbers gave progressively less resistance, and at greater spacings round timbers offered progressively less resistance. From a practical standpoint, it would seem that for a spacing of 6¾ diameters—6¾ ft. center to center for 12-ft. sets in a 5x7 ft. drift—both square and round timbers would offer the same resistance, but, if sets were closer together, square timbers would offer less resistance than round timbers. On the other hand, if the spacing of sets was increased over 6¾ diameters, round timbers would give a smaller resistance to the flow of air. Also the maximum resistance of round timbers was found at a spacing corresponding to 6¼ diameters, being less for greater or smaller spacing. The maximum resistance of square timbers was found at about 9½ diameters, being progressively less as spacings were increased or decreased from this point.

Various forms of streamlined timbers were tried, but they seemed to offer no practical advantage when used at the spacings ordinarily considered suitable for mine sets. Beveling the upstream edge of square timbers reduced resistance to the flow of air, but beveling the downstream edge increased the resistance. As shafts are commonly the main intake or exhaust airways for mines, and any decrease in resistance to the flow of air would be a distinct advantage from the standpoint of the cost of power for ventilation, it was thought advisable to make a series of tests on a two-compartment shaft, Fig. 1. Using 1-in. timbers, the shaft would have two compartments each 4½x6 in. in the clear, corresponding on a 1/12th scale to 4½x6-ft. compartments in practice. From the previous research on drift sets, it did not seem that special streamlined shapes of wall or end plates would have any advantage over plain round or square timbers in regard to resistance offered at the spacing commonly used in shaft sets,

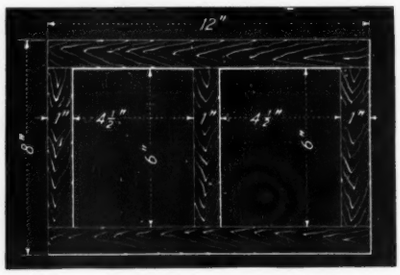


Fig. 1 . . . A plan view of one of the shaft sets used in the model shaft and built on a 1/12 scale

but beveling the upstream edges might give a sufficient reduction in resistance to be worth investigating. Also, some special shape of dividers might be of advantage, as they are exposed to the air current on both sides.

Lord Raleigh's principle of dynamic similarity showed that results from small-scale models could be applied to actual installations provided certain requirements were fulfilled, and tests on models have been shown to approximate rather closely to results achieved in practice[2, 3]. In this investigation, the question of dynamic similarity did not enter, as all tests were made in the same duct and results were directly comparable. Very much the same relation could be expected in actual mine-timber installations.

A long fabricated metal duct with pitot tubes and gages was used in making tests. The duct measured 46 ft. in length and was 8x12 in. in section. It was built, in six lengths, of No. 10 boiler plate fastened at the edges with 1¼x1¼x⅛-in. angle irons, held together at 5-in. intervals by bolts. Cork gaskets were used to make it airtight. A transition piece 2 ft. 6 in. long connected it to the 18-in. circular intake of the fan. A four-vane straightener, 18 in. long, was placed at the intake of the duct.

The fan used was a Silentvane Size 60, Design 5, made by the B. F. Sturtevant Company. It was driven at 3,000 r.p.m. through a V-belt drive by a 7½-hp. G.E. squirrel-cage motor, running at 1,800 r.p.m. It was operated as an exhaust fan, a sliding gate being placed in the fan discharge to regulate velocity of flow in the duct.

Procedure in Tests—The instruments used and the general method followed were similar to those described in the study of drift timbering[1]. The static pressure drop caused by the different forms of timbering was measured over a length of 20 ft., the timbering extending over a greater length, so that conditions of flow would be those actually occurring inside the timbers. Velocity of flow was measured at a point 13 ft. downstream from the end of the timbering to insure satisfactory conditions for making a nine-point traverse with pitot tubes. Later, Hayes found that a factor of 0.915 was sufficiently accurate to be used as a multiplier of the center velocity pressure only to give the average velocity pressure, if the center velocity pressure was 0.11 in. of water gage or above, but the nine-point traverse was used if the velocity pressure at the center was less. Crouch determined that, instead of finding the average velocity by averaging the square roots of the individual velocity pressures in a nine-point traverse, it was sufficiently accurate to use the square root of the mean of the separate velocity pressures in a traverse. This change shortened the time needed to calculate average velocity from a traverse.

In the first series of tests, square timbers were used in the shaft sets, and the resistance offered by the 20-ft. section was taken as the standard. Then various forms of built-up dividers were tried, the other timbers of the sets remaining unaltered. The results from these tests are shown in Fig. 2, where the hatched areas are the additions made to the original square divider, which is not shaded. The number in brackets is the number of the test run; the percentages given just below are the percentage increase (+) or decrease (—) in resistance in pounds per square foot over the 20-ft. section that is caused by the special shape of the divider as compared to the plain square divider; the figures in pounds per square foot are the

measured resistances to the flow of air. Thus the variation in pressure from +14.8 per cent to —23.7 per cent of the resistance of the standard divider is caused by the difference in shape of the divider. A triangular shape added downstream increased the resistance 14.8 per cent, but the same shape added upstream decreased the resistance 14.8 per cent, a total change of 29.6 per cent or 1.3 in. of water gage, as shown by tests 10 and 2.

A half-round section, Test 4, added upstream reduced the resistance 11 per cent, or 2.6 lb. per square foot, compared with a standard square divider. Thus it was a little less effective than the triangular section. Adding either section would reduce the open space in the shaft between dividers from 4 to 3 in. In comparing the two added shapes, the half-round would require half as much timber as the triangular form, since two half-round pieces could be cut from a round timber. The triangular section gave an added reduction in resistance of 3.8 per cent or 0.9 lb. per square inch compared with the half-round section. The smallest resistances were given by the compound shapes used in tests 11, 5, and 12, in which sections were added to both upstream and downstream faces of the dividers. Such results were to be expected, as these shapes approach a streamlined form of timbering. It is interesting to note that the addition of another square divider, as in tests 7 and 13, may have a favorable or an unfavorable result, depending on its position; that is whether it is placed upstream or downstream. Thus, if dividers in a shaft are to be doubled or reinforced, it would be far more advantageous to place the addition on the downstream face of the main divider, other things being equal, than to have it upstream. The difference in resistances in the two positions is about 4/5 of an inch of water gage for 20 ft. of shaft.

In Fig. 3 are given the results of tests on entire shaft sets instead of dividers only; that is, both end plates and wall plates were changed in shape as well as dividers. The figure does not show the changes in form of the wall plates, but in all cases they were changed in the same manner as the end plates. A triangular section, in the form of an isosceles triangle, is made from one square timber and is used on dividers only. On the wall and end plates the fillers make an angle of 45 deg. with the axis of the shaft.

From left to right the tests show decreasing resistances to the flow of air. A test was first made on plain sets, and then on different built-up shapes by fastening pieces to the original square-sets with glue. As a check, after tests were completed and the added pieces were removed, another run was made on the plain

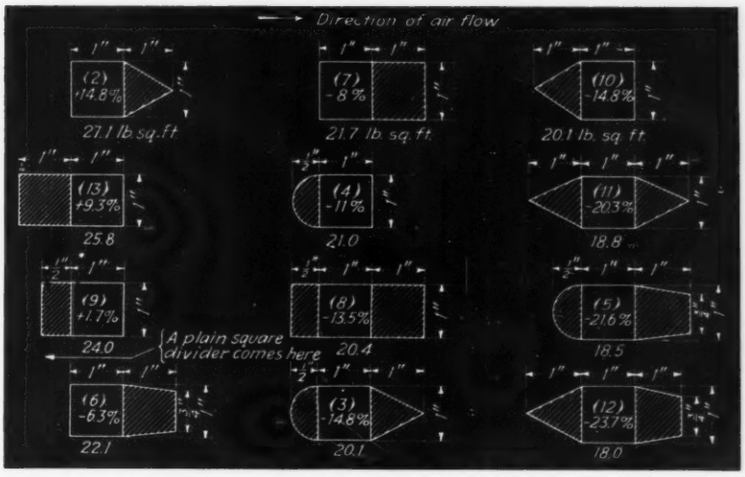


Fig. 2 . . . Comparative tests on resistance of different shapes of dividers. The percentages are the increase or decrease in resistance in per cent in pound per square foot over a 20-ft. length of duct, at a velocity of 1,800 ft. per min. Number of test is given in brackets. Resistance of plain square timbers of 23.6 lb. per square foot is taken as the standard

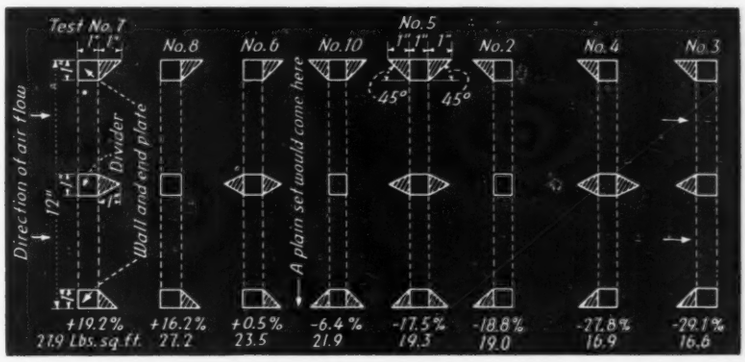


Fig. 3 . . . Resistance of various shapes of shaft sets compared to that of plain square-sets (23.4 lb. per square foot) as standard. Velocity of air is 1,800 f.p.m. Length of test section is 20 ft.

sets. The two tests gave identical results, indicating that the sets had not been disturbed from position during the different tests.

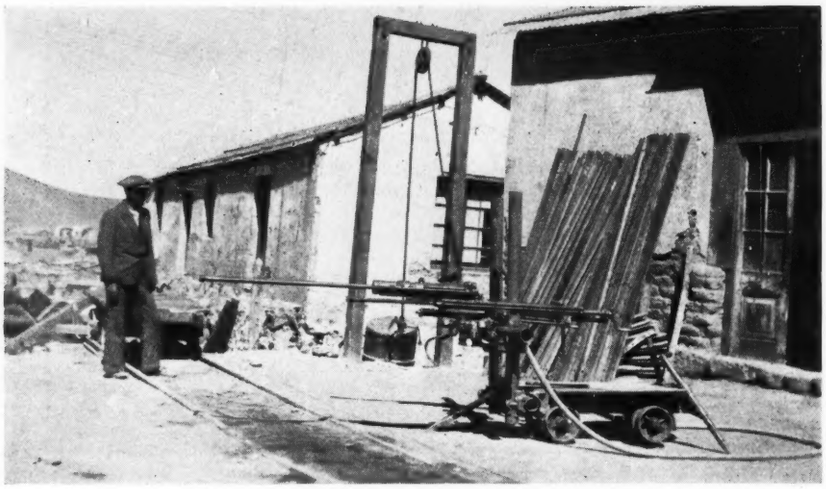
In general, the effect of adding sections downstream was to increase resistance. Test 3 gave the minimum resistance in the series, and its form is the simplest of all built-up forms, the triangular sections being added on the upstream side only. In the two series of tests (dividers alone and entire sets) the standard of comparison was the plain unaltered set. In the two series the standards gave 23.6 and 23.4 lb. per square foot as the respective resistances. As the sets were torn down and were rebuilt between the tests, and the two series of tests were made by different operators, the agreement is very close. If we take the average as 23.5 lb. per square foot, we see that the resistance, using a triangular upstream addition to the divider alone (Fig. 2, Test 10), is reduced to 20.1 lb. per square foot. In Fig. 3, Test 2, the resistance for 45 deg. blocks on the upstream sides of both wall and end plates, but with divider left square, is 19 lb. per square foot. In other words, filling in on wall and end plates has a slightly greater effect that making the upper face of the dividers triangular. Almost the same effect is achieved by altering the divider alone as by adding to all wall and end plates. However, combining additions to both dividers and wall and end plates gives the minimum resistance, 16.6 lb. per square foot, as shown in Fig. 3, test 3. Such a set gives a reduction of 1.3 in. of water gage over the standard 20-ft. length.

From these tests it would seem that for a two-compartment shaft, timbered in the usual manner with square-sets, a decided reduction in resistance to the flow of air would be achieved by placing triangular blocks on the upstream faces of dividers, wall and end plates. Just how economical this would be depends on the particular case and the conditions that obtain.

[1] "Drift Model Aids in Studying Air Flow." J. R. Aho, W. Henoch, K. G. Pike, and R. S. Lewis. *Engineering and Mining Journal*, March, 1937, p. 140.

[2] "Experiments on the Flow of Air in Ducts." Cook and Statham. *Trans. A.I.M.E.*, Vol. 73, p. 78. 1926–27.

[3] "Application of Model Tests to the Determination of Losses Resulting From the Transmission of Air Around a Mine Shaft Bend." C. Smith. University of Illinois Bulletin 265, 1934.



The jumbo on the surface

The Huanchaca Jumbo

Carriage takes two 3-in. drifters and will go on a small cage without dismounting

Neil O'Donnell

General Manager
Cia. Huanchaca de Bolivia
Pulacayo, Bolivia

IN DRIVING any drift or tunnel, where mechanical shovels are used, it is a distinct advantage to have a piece of equipment carrying the drills, which can be placed in operation soon after the heading is mucked out. In 1938 at the Huanchaca silver mine, at Pulacayo, Bolivia, the staff decided to try to build a small jumbo which could be used for driving drifts, and Ben E. Peet, chief engineer, was asked to design one. The result is the device shown in the accompanying drawing.

This jumbo will safely carry two 3-in. Leyner machines and is short enough to go in a 2½x4-ft. cage without dismounting the machines or bars. It has no clamps, cranks or other devices, is not heavy or cumbersome, and requires no more room on a switch than a mine car. For nearly a year it has been actively employed in driving drifts.

It consists of two sets of trucks, surmounted by channels with the hollow side toward the center. Through the channels, just forward of the front wheels, a 3-in. bar is passed and by use of universal clamps two upright bars are attached. To these bars the drilling arms are attached by universal clamps, preferably passing in the rear of the uprights for greater stability.

Between the uprights and welded to the floor of the jumbo is a large hinge, the forward end of which is pointed. When the jumbo is in operation the hinge drops forward and engages in the ground, which prevents the jumbo from being pulled forward when attempting to crank out a stuck steel. On the rear end are two large spikes, one pointing slightly forward and out. The other points rearward and out. These are bored and have a pin to hold them clear off the track when the jumbo is being moved. These spikes were not provided in the first design. In normal operation they did not seem to be required, but it was found that in loosening or tightening nuts on the machine or bars, the rear end of the jumbo tended to move. This the spikes prevented.

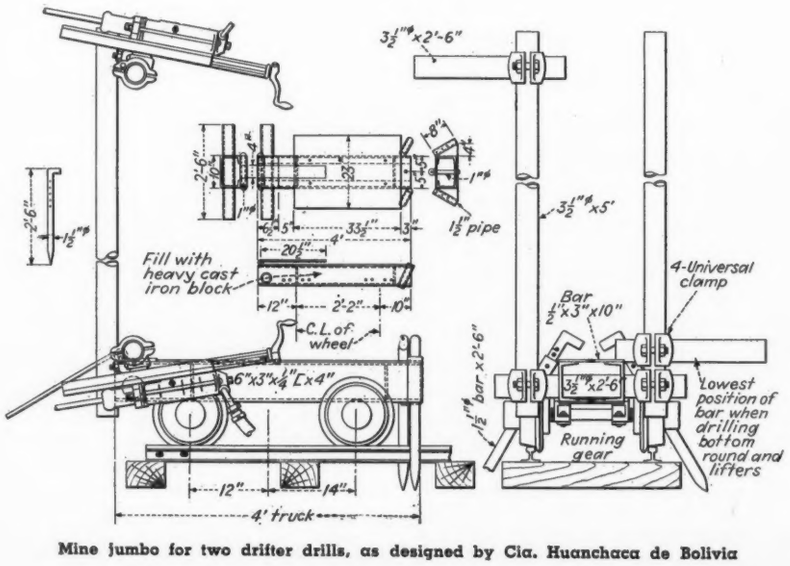
Contrary to general belief, the jumbo displays no great tendency to retreat from the face, and before the spikes were installed, only a shovelful of dirt was placed on the track behind the wheels.

A tendency to tip over forward, due to the weight of the machines ahead of the front wheels, when these were fully cranked out, was overcome by filling the chamber between the channels with three pieces of cast iron. Two pieces fit snugly in the "U" of the channels and a slightly wedge-shaped piece is dropped between them. No difficulty has been had with this.

A plate of ¼-in. steel is welded on the top of the channels and the ends of the channels are closed by welding. This prevents movement of the castings. The spikes are held in pieces of 1½-in. or 2-in. pipe. Extra heavy pipe is preferable.

No difficulty has been had when one machine is out at the end of the arm while the other is close to the column, despite the narrowness of the gage, which is 18 in. In fact, side-swiping on the side of the drift can be done where both machines are drilling on the same side.

This device has been used for driving drifts 9 ft. wide and 8 ft. high, for drilling bottom for ditches, and for starting raises and for side-swiping.



Mine jumbo for two drifter drills, as designed by Cia. Huanchaca de Bolivia

NEW BOOKS

STRATEGIC MINERAL SUPPLIES. *By G. A. Roush. McGraw-Hill Book Company, Inc. Pp. 485. Price, $5.*

THIS VOLUME is most timely. It comes from one of the country's best informed individuals. It contributes a genuine service for any firm or individual who must survey or pay any attention to questions of supply of that small group of strategic minerals to which present war problems have again directed general attention.

Dr. Roush has for many years been one of the country's leading students and authors on mineral economics. His annual contributions as editor of "The Mineral Industry" are too widely known to require more than mention in order to prove Roush's real position as an outstanding author in this field. The present book has not only this background of mineral economics to draw on. It is based on a large number of elaborate official reports to which Dr. Roush has had access and to which he makes generous acknowledgment in his preface. The result is an authoritative, well-balanced presentation regarding manganese, nickel, chromium, tungsten, tin, aluminum, antimony, mercury, platinum, mica, iodine, and nitrogen.

The presentation in each of these chapters is simple, understandable, and informative. One does not need to be in any sense a specialist in either mineral economics or metal utilization to profit from mere reading of any of these presentations of the book on any commodity in which one may have interest. Furthermore, the concise, conveniently arranged statistical matter which has been brought together from official and industrial sources gives great reference value even for the specialist who may already know the principles explained in the interpretative part of the text.

Roush has taken a middle-of-the-road course in his discussion. He believes in military preparedness, but mainly as a matter of good sense and protection of American industry. This evident attitude gives the highest credibility to all of the subject matter which is based on opinion, rather than mere fact. But, fortunately, the reader has no difficulty in distinguishing what is fact and what is merely the author's opinion. Thus even the highly partisan will profit by reading, and will not be too much offended even when he disagrees in detail.

R. S. MCBRIDE

GEOLOGY AND ENGINEERING. *By Robert F. Legget. Published by McGraw-Hill Book Company, 330 West 42d St., New York, N. Y. Pp. 650. Price $4.50.*

GEOLOGISTS will be happy to learn that this book proclaims the importance of their knowledge and experience to the civil engineering profession and, strange as it may seem, it is, strictly speaking, not written by a geologist. The author's background lies exclusively in the practical and academic field of civil engineering and his desire is to point out to the civil engineer as well as to the geologist how these professions can cooperate and advance the perfection and security of constructing dams, hydroelectric plants, tunnels and other engineering projects. Professor P. G. H. Boswell, F.R.S., of London, in his foreword says: "It is well known that adequate geological investigation of natural conditions in engineering undertakings in the past would have resulted in the saving of human life by the prevention of disasters; it has frequently been the means of effecting a considerable reduction in the cost of engineering works and of avoiding the trouble and expense of litigation."

Part I of the book is entitled "An Introduction to Geology," which can be skipped by geologists. Part II, "Geology as Applied to Civil Engineering," is important for geologists and civil engineers. Part III is a very complete reference section of geological terms commonly encountered; geological surveys of the English-speaking world, and names of geological societies and periodicals.

Part II is a thorough and well-written section going into all the phases of applying geology to civil engineering, such as open excavation with movement and landslides, transportation routes, bridge and dam foundations, building foundations, materials of construction, and soil mechanics. The book is an important and practical contribution to engineering and will stimulate both geologists and civil engineers toward a better understanding for mutual cooperation.

H. C. C.

PUBLIC SPEAKING FOR TECHNICAL MEN. *By S. Marion Tucker. McGraw-Hill Book Company, New York and London. Pp. 397. Price $3.*

IF YOU HAVE a pet aversion to public speaking by technical men as you hear it at conventions, and if you would like to know just what is wrong with so much public speaking and how to correct it, you will find this book helpful and interesting from cover to cover. The author treats with gentle satire the faults and frailties of most public speakers, but, more important, he gives sound practical advice on the subject that should be taken to heart by all men who have to face an audience. The book abounds in illustrations of good and bad technique in organizing and preparing a speech, platform presence, use of the voice, and consideration for the audience. The treatment of the subject is as lively and dynamic as we wish more speech makers might be.

HANDBOOK OF MICA. *By Ramani Ranjan Chowdhury. Published by Thacker, Spink & Company, Ltd., Calcutta, India. Pp. 340. Price 22s. 6d.*

INTEREST in the recovery of mica has increased in recent years, partly because of its strategic importance. Those engaged in the marketing of the mineral know that expert knowledge is essential in producing and handling the product. The exacting needs of the ultimate consumer must be met. The author, a specialist in his field, has covered the subject in great detail and supplies answers to nearly all of the questions frequently asked by owners of mica-bearing properties who believe that they see big opportunities ahead. His volume opens with a chapter on the geological aspects of mica, and, progressively, covers mining, commercial preparation, marketing, and utilization. Though the Indian mica industry naturally receives most attention in the handbook, operations in other producing areas are by no means neglected.

THE MINERAL INDUSTRY — Statistics, Technology, and Trade During 1938. *Edited by G. A. Roush. McGraw-Hill Book Company, New York and London. Pp. 784. Price $12.*

VOLUME 47 of this annual continues the long line of mineral statistical studies founded by Richard P. Rothwell. Thirty-five contributors, each a specialist in his subject, have covered the metals and non-metals in the customary authoritative manner. Useful supplementary tables give the value of foreign currencies in United States money, current tariffs on mineral and metal products, weight-conversion factors, professional and trade association in the United States, and a list of the State geologists, mine commissioners, and mine inspectors.

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Essential Minerals for National Defense. Bulletin 250, Mining and Metallurgical Society of America, 90 Broad St., New York. Pp. 9.

Gypsum and Anhydrite. Forrest T. Moyer. Information Circular 7049, U. S. Bureau of Mines, Washington, D. C. Pp. 45.

Canada. Report of the Department of Mines and Resources for the year ended March 31, 1938. Ottawa. Pp. 330. Price 50c.

Nickel Content of an Alaskan Basic Rock By John C. Reed. Bull. 897-D, U. S. Geological Survey. For sale by Superintendent of Documents, Washington, D. C. Pp. 6. Price 5¢.

Blast Furnace Practice. By Ralph H. Sweetser. A manual on all aspects of the production of pig iron. McGraw-Hill Book Co., 330 West 42d St., N. Y. Pp. 356. Price $4.

Transvaal Chamber of Mines, 1938. Forty-ninth annual report. Published by the Chamber, Johannesburg, South Africa. Pp. 152.

Metallurgical Study of Idaho Placer Sand. By A. W. Fahrenwald, Joseph Newton, W. W. Staley, Robert E. Shaffer. Pamphlet 51, Idaho Bureau of Mines, Moscow, Idaho. Pp. 10.

Cambrian Formations of the Eureka and Pioche Districts, Nevada. By Harry E. Wheeler and Dwight M. Lemon. Geology and Mining Series No. 31. Nevada State Bureau of Mines, University of Nevada, Reno. Pp. 60. Price 25¢.

Summary of the

MARKETS

DESPITE the world-wide dislocation of trade in non-ferrous metals, resulting from the European War, domestic consumers bought large tonnages of copper, lead, and zinc during September at rising prices. The *E. & M. J.* index of prices advanced from 73.88 in August to 83.07 in September. The uplift reflected sharp advances in copper and zinc.

The outstanding event during September was the drastic action taken in the United Kingdom for the control of prices of non-ferrous metals to protect home trade. Under the circumstances, the London Metal Exchange remained closed to all regular business in copper, lead, and zinc and those foreign producers who had relied on London quotations as a guide to world prices found themselves in a difficult position. On export copper for shipment from the United States, most producers switched to a flat f.a.s. dollar basis, and our export quotations over the last two weeks of the month were based chiefly on such transactions. The London equivalents, owing to the decline in sterling exchange, dropped close to 9¢ a pound on Empire electrolytic. (Prices fixed in the United Kingdom by the Ministry of Supply appear elsewhere in this issue.)

Domestic copper was active, sales for the month totaling 183,627 tons, against 38,276 tons in August and 183,150 tons in July. The price advanced to 12¢, Valley. A veiled warning by President Roosevelt to the effect that ample copper could be produced here at 12½¢ attracted interest.

Lead producers restricted offerings of the metal to hold frightened consumers in check, and they raised the price only 45 points in the face of heavy purchases. The price of zinc advanced from 4.75c, St. Louis to 6.50¢. Spot tin was wholly nominal most of the month on scanty offerings, but forward metal sold around 45¢. Gold in London was established at 168s., a new high.

UNITED STATES MARKET

1939 Sept.	Electrolytic Copper, Domestic (a) Refinery	Electrolytic Copper, Export (b) Refinery	Straits Tin, New York	Lead, New York	Lead, St. Louis	Zinc, St. Louis
1	10.275	10.175	50.5000	5.05	4.90	4.75
2	10.775	11.000	52.0000	5.05	4.90	5.00
4	Holiday	11.000	Holiday	Holiday	Holiday	Holiday
5	10.775	11.425	60.0000	5.25	5.10	5.65
6	11.775	11.700	60.0000	5.25@5.50	5.10@5.35	5.90@6.00
7	11.775	11.800	62.5000	5.50	5.35	6.00
8	11.775	11.800	64.7500	5.50	5.35	6.00
9	11.775	11.800	66.0000	5.50	5.35	6.00
11	11.775	11.900	70.0000	5.50	5.35	6.00@6.25
12	11.775	11.925	70.0000	5.50	5.35	6.25
13	11.775	11.875	74.5000	5.50	5.35	6.25
14	11.775	11.875	72.0000	5.50	5.35	6.25
15	11.775	11.750	68.0000	5.50	5.35	6.25
16	11.775	12.000	68.0000	5.50	5.35	6.25
18	11.775	11.625	68.0000	5.50	5.35	6.25
19	11.775	11.750	68.1000	5.50	5.35	6.25
20	11.775	11.750	68.1000	5.50	5.35	6.25
21	11.775	11.750	68.0000	5.50	5.35	6.25
22	11.775	11.750	67.0000	5.50	5.35	6.25
23	11.775	11.750	66.0000	5.50	5.35	6.25
25	11.775	11.750	65.0000	5.50	5.35	6.25
26	11.775	11.875	64.0000	5.50	5.35	6.25
27	11.775	11.875	62.2500	5.50	5.35	6.25@6.50
28	11.775	11.950	60.0000	5.50	5.35	6.50
29	11.775	11.950	60.0000	5.50	5.35	6.50
30	11.775	12.000	60.0000	5.50	5.35	6.50
			AVERAGES FOR MONTH			
	11.635	11.685	64.588	5.449	5.299	6.104
Sept.			**AVERAGES FOR WEEK**			
6	10.775	10.925	54.350	5.155	5.005	5.220
13	11.775	11.850	67.958	5.500	5.350	6.104
20	11.775	11.792	68.700	5.500	5.350	6.250
27	11.775	11.792	65.375	5.500	5.350	6.271
Sept.			**CALENDAR WEEK AVERAGES**			
2	10.358	10.354	49.646	5.050	4.900	4.792
9	11.575	11.588	62.650	5.425	5.275	5.920
16	11.775	11.888	70.417	5.500	5.350	6.229
23	11.775	11.729	67.533	5.500	5.350	6.250
30	11.775	11.900	61.875	5.500	5.350	6.396

SILVER, GOLD, AND STERLING EXCHANGE

NEW YORK AND LONDON

1939 Sept.	Sterling Exchange, "Checks"	Sterling Exchange, "90-day demand"	Silver (c), New York	Silver (c), London	Gold, London	Gold (d) United States
1	4.20000	(f)	35.5000	19.7500	160s	$35.00
2	4.20000	4.16000	(e)	(e)	(f)	35.00
4	Holiday	Holiday	Holiday	(f)	(f)	Holiday
5	4.05000	(f)	35.5000	20.6250	168s	35.00
6	4.03000	3.98000	36.2500	21.0625	168s	35.00
7	4.04000	3.99500	36.7500	21.3125	168s	35.00
8	4.04750	4.01250	36.7500	21.3125	168s	35.00
9	4.04000	4.00500	(e)	(e)	(e)	35.00
11	4.04500	4.01000	36.1250	20.9375	168s	35.00
12	4.03000	3.99500	36.0000	20.8750	168s	35.00
13	4.02000	3.98500	36.3750	21.5625	168s	35.00
14	3.83000	3.79500	36.0000	21.5000	168s	35.00
15	3.77000	3.72500	36.2500	22.1250	168s	35.00
16	3.87000	3.83000	(e)	(e)	(e)	35.00
18	3.80000	3.76000	36.7500	22.5625	168s	35.00
19	3.91000	3.86000	38.5000	23.4375	168s	35.00
20	3.88000	3.83000	38.5000	23.5000	168s	35.00
21	3.95000	3.91000	38.7500	23.5000	168s	35.00
22	3.98500	3.93500	39.2500	23.5000	168s	35.00
23	3.99250	3.94000	(e)	(e)	(e)	35.00
25	3.98500	3.93000	39.2500	23.5000	168s	35.00
26	3.99000	3.93500	39.1250	23.5000	168s	35.00
27	4.01000	3.96500	37.2500	23.5000	168s	35.00
28	4.01000	3.96500	35.2500	23.0000	168s	35.00
29	4.01000	3.96000	35.0000	22.5000	168s	35.00
30	4.01000	3.97000	(e)	(e)	(e)	35.00
			AVERAGES FOR MONTH			
	3.98820	.....	36.956	22.178	.....	35.00
Sept.			**AVERAGES FOR WEEK**			
6	4.15000	.....	35.688	.....	.....	.....
13	4.03708	.....	36.400	.....	.....	.....
20	3.84333	.....	37.200	.....	.....	.....
27	3.98542	.....	38.725	.....	.....	.....

Calendar week averages: New York Silver, Sept. 2nd, 36.125; 9th, 36.313; 16th, 36.150; 23rd, 38.350; 30th, 37.175.

(e) Not quoted (Saturday).

(f) No quotation.

THE above quotations for major non-ferrous metals are our appraisal of the important United States markets, based on sales reported by producers and agencies. They are reduced to the basis of cash, New York or St. Louis, as noted. All prices are in cents per pound.

(a) Net prices at refineries on Atlantic seaboard. To arrive at the delivered New England basis add 0.225c. per pound, the average differential for freight and delivery charges.

(b) Export prices are net at refineries on the Atlantic seaboard and include sales of domestic copper in the foreign market. Owing to the European War and the disruption of normal trade relations, our export copper quotations for September were based largely on f.a.s. transactions, ex United States ports.

Copper, lead and zinc quotations are based on sales for both prompt and future deliveries; tin quotations are for prompt delivery only.

Quotations for copper are for the ordinary forms of wirebars and ingot bars; cathodes are sold at a discount of 0.125c.

Quotations for zinc are for ordinary Prime Western brands. Zinc in New York commands a premium over the St. Louis basis equal to the freight differential. Contract prices for High Grade zinc delivered in the East and Middle West in nearly all instances command a premium of 1c per pound over the current market for Prime Western but not less than 1c over the *Engineering and Mining Journal's* average quotation for Prime Western for the previous month.

Quotations for lead reflect prices obtained for common lead, and do not include grades on which a premium is asked.

(c) Silver other than newly-mined domestic, by Handy & Harman. Under Treasury order of July 6, 1939, the price on domestic newly-mined silver mined subsequent to July 1, 1939, was fixed at 71.11c per troy ounce. Handy & Harman's quotation on newly-mined domestic silver, 999 fine, was 70⅝c throughout September.

(d) U. S. Treasury's gold price. Actual payment by the United States Treasury for gold in domestic and imported ore or concentrate is at 99.75 per cent of the price quoted by the Treasury, which at present is equal to $34.9125.

PRICES OF METALS • MISCELLANEOUS QUOTATIONS

LONDON MARKET

1939 Sept.	COPPER Standard Spot	COPPER Standard 3 months	COPPER Electro Bid	TIN Standard Spot	TIN Standard 3 months	LEAD Spot Buyers	LEAD Spot Sellers	LEAD 3 months Buyers	LEAD 3 months Sellers	ZINC Spot Buyers	ZINC Spot Sellers	ZINC 3 months Buyers	ZINC 3 months Sellers
1	London Metal Exchange Closed for War Emergency												
4	"	"	"	"	"	"	"	"	"				
5	"	"	"	"	"	"	"	"	"				
6	No Quotations			229.8750	227.5000	No Quotations							
7	"	"	"	229.7500	229.7500	"	"	"	"	"	"	"	"
8	"	"	"	229.7500	229.7500	"	"	"	"	"	"	"	"
11	"	"	"	229.7500	229.7500	"	"	"	"	"	"	"	"
12	"	"	"	229.7500	229.7500	"	"	"	"	"	"	"	"
13	"	"	"	—Not Quoted—		"	"	"	"	"	"	"	"
14	"	"	"	—Not Quoted—		"	"	"	"	"	"	"	"
15	"	"	"	—Not Quoted—		"	"	"	"	"	"	"	"
18	"	"	"	229.8750	229.5000	"	"	"	"	"	"	"	"
19	"	"	"	229.0000	228.2500	"	"	"	"	"	"	"	"
20	"	"	"	229.0000	227.7500	"	"	"	"	"	"	"	"
21	"	"	"	228.2500	227.5000	"	"	"	"	"	"	"	"
22	"	"	"	227.7500	226.2500	"	"	"	"	"	"	"	"
25	"	"	"	228.2500	226.2500	"	"	"	"	"	"	"	"
26	"	"	"	229.5000	227.5000	"	"	"	"	"	"	"	"
27	"	"	"	229.5000	227.5000	"	"	"	"	"	"	"	"
28	"	"	"	229.5000	228.0000	"	"	"	"	"	"	"	"
29	"	"	"	229.8750	228.2500	"	"	"	"	"	"	"	"
Average for month				229.292	.....								

Prices for lead and zinc are the official prices for the first session of the London Metal Exchange; prices for copper and tin are the official closing buyers prices. All are in pounds sterling per long ton of 2,240 lb.

CURRENT PRICES — MISCELLANEOUS METALS, ORES, AND NON-METALLIC MINERALS

Quotations cover wholesale lots, prompt shipment, f.o.b. New York, unless otherwise stated

(Oct. 2, 1939)

MISCELLANEOUS METALS

Aluminum, ingot, 99 plus per cent, lb	20c.
Antimony, domestic, spot, lb	14.00c.
Bismuth, ton lots, lb	$1.10
Cadmium, commercial sticks, lb	65c.
Calcium, lb., ton lots 97 @ 98 per cent	Nominal
Chromium, 97 per cent grade, lb	85c.
Nickel, electrolytic cathodes, lb	35c.
Magnesium, 99.8 per cent, carolads, lb	27c.
Palladium, troy oz	$24.00
Platinum, (Official quotation) troy oz	$42.00
Quicksilver, flask of 76 lb., 100 flasks or more	$150.00
Radium, mg. radium content	$25.00@$30.00
Selenium, 99.5 per cent, lb	$1.75
Silicon, minimum 97 per cent, spot, lb	16.50c.
Tellurium, lb	$1.75
Thallium, 100 lb. or more, lb	$6.50
Titanium, 96 to 98 per cent, lb	$5.00

METALLIC ORES

Beryllium Ore, f.o.b. mines, ton	$30.00@$35.00
Chrome Ore, 48 @ 50% Cr_2O_3 c.i.f. Atl. ports, long ton	$25.00@$28.00
Iron Ore, Lake Superior, Lower Lake ports, long ton:	
Old Range bessemer	$5.25
Mesabi bessemer	$5.10
Old Range non-bessemer	$5.10
Mesabi, non-bessemer	$4.95
Lead (Galena) 80 per cent, Joplin, Mo., ton	$61.00@$67.00
Manganese Ore, c.i.f. Atlantic ports, long ton unit of Mn:	
52 @ 55 per cent	(b) 45@50c.
50 @ 52 per cent	(b) 45@50c.
44 @ 48 per cent	(b) 40@45c.
Molybdenum Ore, 90 per cent, per lb. of contained MoS_2	45c.
Tungsten Ore, per unit of WO_3:	
Chinese, 65 per cent, duty paid	$23.75
Domestic, 65 per cent and upward	(a) $25.00
Vanadium Ore, per lb. of contained V_2O_5	27½c.
Zinc Ore, Prime, 60 per cent concentrate, Joplin, Mo.; per ton	$44.00

(a) Prices at mines, small lots, usually several dollars less.

METALLIC COMPOUNDS

Arsenious Oxide (arsenic) lb	3c
Cobalt Oxide, 70 @ 71 per cent, lb	$1.67@$1.77
Copper Sulphate, 100 lb	$4.60
Sodium Nitrate, ex vessel, in 200-lb. bags, per 100 lb	$1.42
Sodium Sulphate, bulk ton	$13.00@$15.00

ALLOYS

Berrylium Copper, master alloy, 2.5 to 3 per cent Be, per lb. of contained Be	$15.00
Ferrochrome, 65 @ 70 per cent chromium, 4 @ 6 per cent carbon, lb	10½c.
Ferromanganese, 78 @ 82 per cent, gross ton	$100.00
Ferromolybdenum, 55 @ 65 per cent Mo. lb. of Mo. contained	95c.
Ferrosilicon, 50 per cent, gross ton	$69.50
Ferrotungsten, 75 @ 80 per cent, lb. of W contained	$2.00

NON-METALLIC MINERALS

Asbestos, f.o.b. mines, ton:	
Canadian (Quebec)	
Crude No. 1	$700@$750
Crude No. 2	$150@$350
Spinning fibers	$110@$200
Paper stock	$40@$45
Shorts	$12@$16 50
Vermont	
Shingle stock	$57
Paper stock	$40
Cement stock	$25
Barytes, long ton:	
Georgia, crude	$7.00
Missouri, 93 per cent $BaSO_4$, less than 1 per cent iron	$6.00@$6.50
Bauxite, long ton:	
Domestic, chemical, 55 @ 58 per cent	$6.00@$7.00
Domestic, abrasive, 80 @ 84 per cent	$12.00@$14.00
Dalmatian, 50 @ 55 per cent	(a)$6.00@$7.00
French, 56 @ 59 per cent	(a)$7.00@$8.00
China Clay, f.o.b. mines, ton:	
South Carolina and Georgia, No. 1, bulk	$6.75@$8.00
Delaware, No. 1	$14.50
Feldspar, bulk, ton:	
Potash feldspar, 200 mesh	$17.00
Glass-spar, white, 20 mesh	$11.75
Fluorspar, f.o.b. mines, bulk, Kentucky and Illinois 85–5 per cent, all rail movement, ton	$20.00
Fuller's earth, f.o.b. Georgia or Florida, ton	$7.00@$14.00
Magnesite, per ton:	
Dead-burned, f.o.b. California	$25.00
Dead-burned, f.o.b. Washington	$22.00
Mica, per lb., North Carolina, No. 1 and 2 quality:	
1½ x 2 in	25@30c.
2 x 2 in	40@50c.
3 x 3 in	$1.00@$1.20
3 x 4 in	$1.30@$1.40
3 x 5 in	$1.50@$1.70
White, ground, 70 mesh, ton	$60.00@$80.00
Ocher, Georgia, ton	$19.00@$22.00
Pyrites, Spanish, per long ton unit of S, c.i.f. Atlantic ports	12c.
Silica, in bags, 325 mesh, ton	$18.00@$40.00
Sulphur, Texas mines, long ton	$16.00
Talc, f.o.b. works, ton:	
New York, double air-floated, 325 mesh	$12.00@$15.00
New Jersey, mineral pulp	$8.00@$10.00
Vermont, extra white, 200 mesh	$9.00@ $9.50
Tripoli, Missouri, ton:	
40 mesh, cream colored	$14.50
200 mesh, cream colored	$26.00

(a) Nominal.

IRON AND STEEL

Pig Iron, Valley furnaces, gross ton:	
Bessemer	$23.50
Basic	$22.50
No. 2 Foundry	$23.00
Steel, base prices, Pittsburgh:	
Billets, gross ton	$34.00
Structural shapes, 100 lb	$2.10
Bars, 100 lb	$2.15

Monthly and Yearly

AVERAGE PRICES

SILVER AND STERLING EXCHANGE

	New York		London Spot		Sterling Exchange	
	1938	1939	1938	1939	1938	1939
January	44.750	42.750	19.895	20.305	499.895	466.775
February	44.750	42.750	20.159	20.370	501.722	468.472
March	44.446	42.750	20.088	20.280	498.394	468.370
April	42.750	42.750	18.880	20.031	498.046	467.778
May	42.750	42.750	18.731	20.123	496.673	467.988
June	42.750	41.955	18.945	19.505	495.772	468.137
July	42.750	34.944	19.356	16.952	492.855	468.031
August	42.750	35.951	19.389	17.719	488.044	460.383
September	42.750	36.956	19.300	22.178	480.240	398.820
October	42.750	.....	19.613	.....	476.785	.....
November	42.750	.....	19.834	.....	470.587	.....
December	42.750	.....	20.083	.....	466.798	.....
Year	43.225	.....	19.523	.....	488.818	.....

New York quotations for silver other than newly-mined domestic, cents per ounce troy, 999 fine, London, pence per ounce sterling silver 925 fine. Sterling exchange (pound sterling) in cents.

COPPER

	F.O.B. Refinery, Electrolytic				London Spot, Standard		London Spot, (a) Electrolytic	
	Domestic		Export					
	1938	1939	1938	1939	1938	1939	1938	1939
January	10.198	11.025	9.908	9.912	41.387	43.125	45.387	48.440
February	9.775	11.025	9.525	9.735	39.597	42.188	43.563	47.375
March	9.775	11.025	9.496	9.888	39.772	42.938	43.582	48.120
April	9.775	10.265	9.443	9.820	39.306	42.031	43.408	47.833
May	9.375	9.833	8.801	9.738	36.668	41.656	40.852	47.528
June	8.775	9.775	8.500	9.738	35.235	41.986	39.417	47.528
July	9.585	9.976	9.573	9.944	39.744	42.899	44.405	48.863
August	9.900	10.261	9.844	10.211	40.591	44.685	45.909	50.409
September	10.028	11.635	9.943	11.685	41.864	(b)	47.148	(b)
October	10.760	.....	10.713	.....	45.646	.....	51.190	.....
November	11.025	.....	10.569	.....	45.244	.....	51.080	.....
December	11.025	.....	10.023	.....	43.428	.....	48.988	.....
Year	10.000	.....	9.695	.....	40.707	.....	45.411	.....

New York quotations, cents per pound. London, pounds sterling per long ton, (a) Bid quotation. (b) No quotations.

LEAD

	New York		St. Louis		London			
					Spot			
	1938	1939	1938	1939	1938	1938 3 mos.	1939	1939 3 mos.
January	4.870	4.826	4.720	4.676	16.135	16.253	14.534	14.744
February	4.632	4.805	4.482	4.655	15.402	15.525	14.283	14.417
March	4.500	4.824	4.350	4.674	15.992	16.075	14.660	14.860
April	4.500	4.782	4.350	4.632	15.579	15.623	14.337	14.533
May	4.400	4.750	4.250	4.600	14.210	14.376	14.483	14.679
June	4.148	4.800	3.998	4.650	13.969	14 012	14.564	14.651
July	4.882	4.854	4.732	4.704	14.924	15.034	14.753	14.856
August	4.900	5.043	4.750	4.893	14.371	14.480	16.040	15.885
September	4.998	5.449	4.848	5.299	15.249	15.401	(a)	(a)
October	5.100	.....	4.950	.....	16.173	16.313	.....	.....
November	5.091	.....	4.941	.....	16.088	16.223	.....	.....
December	4.842	.....	4.692	.....	15.106	15.275	.....	.....
Year	4.739	.....	4.589	.....	15.266	15.383	.....	.....

New York and St. Louis quotations, cents per pound. London pounds sterling per long ton. (a) No quotations.

TIN

	Straits, New York		Standard, Spot, London	
	1938	1939	1938	1939
January	41.548	46.404	183.619	215.435
February	41.373	45.640	183.144	213.906
March	41.219	46.213	183.473	215.375
April	38.430	47.160	168.612	218.389
May	36.885	49.031	162.693	225.591
June	40.376	48.853	177.429	227.511
July	43.428	48.548	192.542	229.833
August	43.276	48.793	192.966	229.869
September	43.369	64.588	193.733	229.292
October	45.263	.....	206.911	.....
November	46.262	.....	213.909	.....
December	46.180	.....	214.450	.....
Year	42.301	.....	189.457	.....

New York quotations cents per pound. London, pounds sterling per long ton.

ZINC

	St. Louis		London			
	1938	1939	1938 Spot	1938 3 mos.	1939 Spot	1939 3 mos.
January	5.000	4.500	14.994	15.173	13.682	13.887
February	4.813	4.500	14.408	14.589	13.522	13.780
March	4.417	4.500	14.364	14.477	13.728	13.961
April	4.141	4.500	13.729	13.919	13.443	13.637
May	4.042	4.500	12.682	12.869	13.717	13.938
June	4.131	4.500	12.890	13.104	14.023	14.223
July	4.745	4.516	14.144	14.371	14.235	14.435
August	4.750	4.719	13.467	13.675	14.628	14.761
September	4.846	6.104	14.040	14.246	(a)	(a)
October	5.012	.....	15.083	15.232	.....	.....
November	4.924	.....	14.366	14.550	.....	.....
December	4.500	.....	13.709	13.861	.....	.....
Year	4.610	.....	13.990	14.172	.....	.....

St. Louis quotations, Prime Western, cents per pound. London, pounds sterling per long ton. (a) No quotations.

CADMIUM AND ALUMINUM

	Cadmium			Aluminum	
	1938 (a)	1939 (a)	1939 (b)	1938	1939
January	117.500	70.900	58.400	20.000	20.000
February	117.500	67.500	55.000	20.000	20.000
March	117.500	65.278	54.259	20.000	20.000
April	102.500	52.500	50.000	20.000	20.000
May	102.500	52.500	50.000	20.000	20.000
June	102.500	52.500	50.000	20.000	20.000
July	102.500	52.500	50.000	20.000	20.000
August	99.722	56.204	53.704	20.000	20.000
September	84.000	66.700	64.200	20.000	20.000
October	80.000	.....	.....	20.000	.....
November	77.717	.....	.....	20.000	.....
December	72.500	.....	.....	20.000	.....
Year	98.037	.....	.....	20.000	.....

Aluminum in cents per pound, 99 plus per cent grade. Cadmium, cents per pound; (a) average of producer's and plater's quotations; (b) producers' price, commercial sticks.

ANTIMONY, QUICKSILVER, AND PLATINUM

	Antimony (a) New York		Quicksilver (b) New York		Platinum (c) New York	
	1938	1939	1938	1939	1938	1939
January	13.750	11.670	79.240	77.440	36.000	34.440
February	13.750	11.250	76.455	85.227	36.000	35.000
March	13.750	11.269	72.444	87.278	36.000	35.000
April	13.654	11.500	71.019	90.800	36.000	35.000
May	12.460	11.712	74.640	86.769	33.400	35.000
June	11.731	12.000	80.731	86.615	33.231	35.000
July	11.030	12.000	76.860	86.960	36.000	35.000
August	10.880	12.000	75.500	84.407	37.000	35.333
September	11.310	12.910	74.420	140.000	39.000	40.080
October	12.060	.....	73.480	.....	37.960	.....
November	12.250	.....	74.065	.....	36.217	.....
December	11.567	.....	76.769	.....	34.000	.....
Year	12.349	.....	75.469	.....	35.901	.....

(a) Antimony, cents per pound, ordinary brands, in cases; in bulk 12,.472 for September. (b) Quicksilver, dollars per flask of 76 lb. (c) Platinum is dollars per ounce troy.

PIG IRON

	Bessemer		Basic		No. 2 Foundry	
	1938	1939	1938	1939	1938	1939
January	24.50	21.50	23.50	20.50	24.00	21.00
February	24.50	21.50	23.50	20.50	24.00	21.00
March	24.50	21.50	23.50	20.50	24.00	21.00
April	24.50	21.50	23.50	20.50	24.00	21.00
May	24.50	21.50	23.50	20.50	24.00	21.00
June	23.73	21.50	22.73	20.50	23.23	21.00
July	20.50	21.50	19.50	20.50	20.00	21.00
August	20.50	21.50	19.50	20.50	20.00	21.00
September	20.50	22.50	19.50	21.50	20.00	22.00
October	21.50	.....	20.50	.....	21.00	.....
November	21.50	.....	20.50	.....	21.00	.....
December	21.50	.....	20.50	.....	21.00	.....
Year	22.686	.....	21.686	.....	22.186	.....

Iron, dollars per long ton. F. o. b. Mahoning and Chenango Valley furnaces.

PERSONAL ITEMS

W. G. Norrie-Loewenthal, consulting engineer of Vancouver, B. C., is on a visit to South Africa.

Frank F. Kalbe has succeeded **Louis Ware** as president of United Electric Coal Companies.

Geoffrey Gilbert is now geologist for Consolidated Mining & Smelting Company at Trail, B. C.

Dr. S. R. B. Cooke has become research professor of ore dressing at Montana School of Mines at Butte, Mont.

Mustafa Teoman, general secretary of Eti Bank, Ankara, Turkey, sailed for Turkey from New York on Sept. 16.

J. K. Gustafson is now with Hollinger Consolidated Gold Mines, Ltd., with an office in the Royal Bank Building, Toronto, Canada.

R. M. Macaulay has resigned as mine manager of Pamour Porcupine Mines, Ltd., Pamour, Ont., and has been succeeded by **C. E. Anderson.**

G. M. Furnival has resigned from Cline Lake Gold Mines, Ltd. at Lochalsh, Ont., to become assistant geologist with the Geological Survey of Ottawa.

G. G. Campbell has left Val d'Or, Que., for Uchi Lake, Ontario, where he has become mine manager for both Hanaldo Gold Mines and Julda Gold Mines.

J. E. Fyfe has been appointed general superintendent at Royal Paracale Mines, Masbate, P. I., to take the place of James Hopkins, who recently resigned.

Herbert P. Dickey, formerly with Gold Eagle Gold Mines at McKenzie Island, Ontario, has joined the staff of the Aldermac Copper Corporation, Ltd., at Arntfield, Que.

Wendell B. Farris, K. C., of Vancouver, has been appointed president of Hedley Mascot Gold Mines, Ltd., succeeding **E. H. Adams.**

Sydney H. Ball, of Rogers, Mayer & Ball, who recently returned from an examination in the Coeur d'Alenes, has left for a month's professional work in British Columbia.

Otto D. Rohlfs, consulting mining engineer, has returned to his office at 410 Marion Building Seattle, Wash., after spending the summer in professional work in the Willow Creek district of Alaska.

A. H. Richards, general manager of the Selby and Tacoma smelters of American Smelting & Refining Company, with offices in San Francisco, has been appointed a vice-president of the company.

D. D. Baker, who resigned recently as superintendent of Atolia Mining Company, Atolia, Calif., has joined the staff of United States Vanadium Corporation at Bishop, Calif., as research metallurgist.

Mayo D. Hersey, formerly physicist in charge of the physical laboratory, Pittsburgh Experiment Station, United States Bureau of Mines, has joined the staff of the Morgan Construction Company, Worcester, Mass., as research director.

C. E. Prior, formerly managing director of the Wiluna Gold Mines, Western Australia, and consulting engineer to the Consolidated Gold Fields of South Africa's Australian Development Company, visited Vancouver recently on his way to England.

G. S. Davis, formerly manager of the Stag Canyon Branch of Phelps Dodge Corporation at Dawson, N. M., has established headquarters at Morenci, Ariz., where he will become assistant to **H. M. Lavender,** general manager of the corporation.

H. De Witt Smith, mining engineer and a director in Numont Mining Corporation, who was on the S.S. "Athenia," the first passenger vessel sunk as a result of naval operations incident to the current war in Europe, recently arrived in New York safely.

Murray N. Colman, metallurgist, until recently in charge of the large tailings plant of Kennedy Mining & Milling Company, Jackson, Calif., has opened an office at 1414 Mills Tower, San Francisco.

Dugald C. Jackson, Jr., has been selected as dean of the college of Engineering at the University of Notre Dame, Notre Dame, Ind. He is the son of Prof. Dugald C. Jackson, Sr., of Cambridge, Mass., retired professor of electrical engineering at M. I. T.

Dr. Charles Camsell, Deputy Minister of Mines and Resources for the Dominion of Canada, is conducting a personal investigation of the possibilities of the oil industry in the Province of Alberta, having regard in particular to the proposal that a pipe line be constructed to the Great Lakes.

Dr. H. A. Buehler, State Geologist of Missouri, was recently given a testimonial dinner by the citizens of Rolla, Mo., to celebrate the completion of his 30 years as State Geologist. Dr. Buehler is the oldest State Geologist, in point of service, in the United States. A silver geologist's pick was presented to him on the occasion of the dinner.

Sherwin Kelly, Toronto, Canada, visited the Atlin district, British Columbia, last month, where he is engaged in geophysical exploration of buried bedrock channels. He is also operating in Newfoundland in cooperation with the Geological Survey in applying geophysical methods to the location of new copper deposits in the region of Notre Dame Bay.

M. L. Jacobs, formerly general manager of limestone properties of the Raw Materials Division of the Bethlehem Steel Company, has been appointed assistant to Vice-President **C. A. Buck. J. P. Peacock** has been advanced from superintendent of the Bridgeport quarry to general manager of limestone properties, succeeding Mr. Jacobs. **Hubert Merryweather** has been appointed general manager of ore properties.

Karl M. Stewart, assistant manager of Nielson & Company, Inc., is temporarily in charge of the Hong Kong Mines, Ltd., until such time as a new superintendent can be obtained to succeed **B. B. Bassett,** who is retiring. Hong Kong Mines is a Nielson operated property in the British New Territories, China.

F. Don Zellweger, 1939 University of Washington graduate, has secured a lease on the Hatfield tungsten mine, owned by John Hatfield, of Wenatchee, Wash. The mine is about a mile south of the Canadian line in the north-central part of Okanogan County, Wash. Zellweger spent considerable time on the property making a study of the deposit as a basis for his graduation thesis. Preparations are being made for the erection of a mill, which will be installed early next year. Values are in wolframite.

▼ ▼ ▼

OBITUARY

Benson James Bennett, a pioneer in the asbestos mining industry, died at Thetford Mines, Que., recently at the age of 71.

George A. Thorne, Jr., of Chicago, a geologist on Rear Admiral Byrd's first antarctic expedition, was killed in an airplane crash on Sept. 7 near Harrisville, N. H. He was 37.

Mikhail Antonovitch Usov, an eminent Soviet geologist and director of the All-Union Institute of Coordinated Geological Research, died on July 26 of the current year.

William S. Heggaton, pioneer mining man of the Lake Superior iron country, died at Eveleth, Minn., on Sept. 16. He was 76 years old.

Mathew Waite, retired engineer and mining man, formerly of Nevada City, Calif., died in Sacramento, in that State, on Sept. 12, at the age of 80.

Charles M. Schwab, chairman of the board of Bethlehem Steel Corporation for more than 50 years, and for that space of time one of the leading steel men of the United States, died in New York on Sept. 18 at the age of 77.

A. D. Coulter, founder and managing director of the Cornucopia Gold Mines, died in Seattle, Wash., Aug. 27, 1939. About a year ago he retired from active business due to ill health. He was born in Peoria, Ill., in 1871, went to Alaska in 1897, and settled in Seattle in 1906. He is survived by his wife, two daughters, and a brother.

Leonard G. E. Bignell, former editor of *Oil and Gas Journal,* and well-known writer on oil engineering, died recently at Tulsa, Okla., at the age of 60. He came to the United States from Cobham,

England, and settled in Denver, Colo., where he attended public and high school and later took graduation work at the Colorado School of Mines.

John F. Manning, mining engineer who had specialized in mining operations in the Far East since 1903, and discoverer of what is reputed to be the largest placer gold field in Siberia, died in Kunming, China, on Sept. 20, aged 59.

Ira Dudley Travis, a pioneer in the Utah mining industry and president of Eureka Standard Consolidated Mining Company and its affiliated concerns, died in Salt Lake City on Sept. 12 at the age of 80.

George Warren Tower, Jr., geologist and mining engineer, who was on the staff of Guggenheim Brothers from 1918 to 1937, died in Denver, Colo., on Sept. 13 at the age of 67. Mr. Tower received his A.B. degree from Harvard in 1894 and his A.M. degree in 1895. For several years he did geological work for the United States Government and for the last two years he had been a consultant to the Security and Exchange Commission.

William Lawrence Austin, mining and metallurgical engineer, died at his home, Riverside, Calif., on Sept. 17, 1939, at the age of 85. He was born in New York City, but lived much of his early life abroad, receiving his education in the West Indies and Italy, finally graduating from the University of Heidelberg, Germany. He then went to Venezuela, where his father and uncle had long had gold mining interests, and where as a small boy he made his first acquaintance with the mining industry. Returning to the United States, he went to Leadville, Colo., to take charge of the mining interests of Governor Grant, who had been a classmate at Heidelberg. His subsequent experience was typical of his profession in that his work took him to Mexico, Japan, British Columbia, and in the United States to Colorado, California, and Montana. Prominent among his clients were Lee, Higginson & Company, and the Calumet & Hecla Mining Company. During the late eighties and early nineties he was a contributor to technical literature in *Engineering and Mining Journal* and *Mining and Scientific Press.* His name was prominently identified with pyritic smelting, of which he was an advocate and for which he patented a process in 1894. During his residence in Denver he was president of the Colorado Scientific Society. His membership in the A.I.M.E. dates from 1882. For the past 34 years he lived in Riverside, Calif., where he is survived by his wife, whom he married in 1883. He was held in high esteem by members of his profession.

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Letters

Kenya's Gold Possibilities

The Editor:

MR. G. L. WALKER writes as follows on page 64 of your February issue:

"East Africa's gold-producing possibilities seem to have diminished during the past year. Though extensions of the veins are being found in some of the mines being worked in Kenya Colony, it has become increasingly apparent that the sensationally rich discoveries made there a few years ago were the outcrops of only small tonnage deposits."

Statements such as this can do untold harm to a young industry, and for that reason, I offer you the following authentic information in an endeavor to dispel the inaccurate statement quoted and in some measure counteract the probable damaging effects of his article.

Far from diminishing, the gold production of Kenya Colony is steadily increasing, as is borne out by the following figures: 1936, gold produced, £270,000; 1937, gold produced, £380,000; and 1938, gold produced, £520,000. (For verification of these, I would refer you to the annual reports of the Mining and Geological Department of Kenya and which can be obtained from the Crown Agents for the Colonies, Millbank, London, S.W. Gold exports in relation to Kenya exports are now second in value with £520,000.

Prospecting and development of the principal areas are gradually increasing, and, although isolated sensationally rich discoveries are still being made, they are not given the same prominence as they were a few years ago. Because several companies were floated a few years ago, each with the huge capital of approximately £500,000 on the expectation of developing a successful gold mine, later finding that the gold was not there, it should not be concluded that the gold-producing possibilities are diminishing. And because companies were floated with a capital of £500,000 instead of, say, £50,000, the Colony's gold-mining industry should not be blamed for the rash undertakings of company promoters.

There are still large areas that require proving and developing, which can be done only through new financing. I am not alone in my opinion that many opportunities exist for introducing new capital and that if this is cautiously applied, it will be justified by the results.

MAURICE W. GHERSIE,
Secretary,
The Kenya Mining Association

In reply to the foregoing, Mr. Walker writes as follows:

"If further exploration in Kenya Colony discloses large deposits of ore I shall be very much pleased, as I wish Kenya gold miners every possible success. I shall be prompt to report all noteworthy developments.

GEORGE L. WALKER."

Few Prospectors In Tanganyika

The Editor:

AS A READER of your very interesting magazine, which is generally correct in its statements, may I correct that paragraph in page 113 of your February number, headed "Tanganyika Attracts Many Prospectors."

Actually, there are few prospectors in Tanganyika. There are five or six hundred people, many of them living hand to mouth by washing and dry-blowing for gold on the Lupa field, and the 884 prospecting licenses were mainly issued to these people.

The quantity of diamonds, tungsten, lead phosphates, and red ocher produced is negligible. Coal is certainly known to exist, but it is so far from rail and port as to be quite useless.

Partly because of the German agitation, but more owing to the apathy and incompetence of the Government, capital is almost impossible to get for mining development, which may be said to be stagnant. One mine discovered in 1925, and showing in the outcrops seven and eight feet of stone over long distances, has taken until this year to get going; another has taken six years, and several others are on their last legs.

Compared with Canada, Australia, and the U. S. A., values are low, roads are bad, and labor, though cheap, gets worse every year owing to lack of Government control.

G. H. NUTTING

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Minto Recovery and Costs

The Editor:

I NOTE that in the article by John B. DeMille in the *E. & M. J.* you report the recovery of the Minto Gold Mines, Ltd., at $2.26 per ton, with working costs of $3.17 per ton. This is entirely wrong.

In May 1938 we resumed operations at our Jubilee mine after having been closed since June 1937. At the same time we undertook the development and salvage of a small orebody at our Copper mine. Recovery from 4,899 tons of copper ore ran $11.57 per ton, with working costs of $5.83 including development. Thirty-five tons per day of this ore was milled from Aug. 1 to Dec. 17.

The Jubilee yielded 2,962 tons of $5.81 ore, with working costs of $5.94 per ton. This ore came entirely from development. Twenty-five tons per day were fed to the mill from Sept. 4 to Dec. 31.

Development of the Jubilee mine is continuing after the location of what appears to be the apex of a new orebody. This ore is on the south end of the mine on the fifth or bottom level. Salvage of some marginal ore from above the fifth level largely covers the cost of this development. The mill is currently handling about 80 tons a day of this ore. A winze has been started to test this ore below the bottom level.

R. D. CAYLOR

What Metal Statistics Show

DOMESTIC PRODUCERS of copper, lead, zinc, iron, quicksilver, and other metals are stepping up their operating schedules to meet the suddenly changed situation brought on by heavy inventory demand for metals during September, because of the European war. Greater exploration and development is reported in districts where tungsten, manganese, and chrome ore deposits are found. Employment at the mines has gained, general wages increases have been made, and producers believe the improved industrial outlook will necessitate greater mine output, for at least the remainder of the year.

On Oct. 1 the Bureau of Mines announced the inauguration of monthly canvasses on the production, consumption, and stocks of strategic minerals commodities.

This action was prompted by the need for current accurate data on certain domestic and imported raw materials to assist Government agencies as well as industry in meeting the various problems presented by the interruption of shipping resulting from the European war. Secretary of the Interior Ickes stated he had been advised by Dr. John W. Finch, Director of the Bureau of Mines, that manufacturers have on hand fairly large stocks of strategic minerals and that no immediate shortages are anticipated. He also pointed out that current data on industrial mineral raw materials would be invaluable to private enterprise and urged patriotic cooperation of business in the effort of the Bureau of Mines to render a timely and essential service.

Consumption of copper here has increased in the last few months, and, according to one accounting on fabricators' deliveries, the use of metal in this country amounted to 63,000 tons for August, against 54,000 tons in July. At present, it is believed, the rate is above 70,000 tons. The Department of Commerce reports that 39,658 tons of refined copper were exported from the United States (foreign and domestic metal) during August, against 29,096 tons in July and 35,355 tons in June.

The monthly statistics of the copper industry have not been issued for August, due to failure to receive data from abroad, and the domestic figures have not been released owing to the "limited emergency."

▶LEAD—Production of lead during the last quarter of this year will show a steady rise, as demands by consumers during September forward are expected to be well above the average of 41,000 tons maintained up to September. Stocks at refineries declined 6,032 tons in August and shipments to consumers totaled 45,025 tons. Shipments in September are expected to be very high.

Anxiety among consumers to acquire metal has been commented on by Mr. Clinton Crane, president of St. Joseph Lead Company. (See page 77)

Figures on refined lead for July and August, in short tons, according to the American Bureau of Metal Statistics, follow:

	July	August
Stock at beginning	129,636	124,017
Production:		
Domestic ore	34,926	36,556
Secondary and foreign	2,095	2,444
Totals	37,021	39,000
Domestic shipments	42,636	45,025
Stock at end	124,017	117,985

E & M J Weighted Index of Non-Ferrous Metal Prices

(100 is composite for 1922-3-4)

1929	110.33	1934	69.56
1930	82.87	1935	74.66
1931	60.20	1936	73.45
1932	48.26	1937	90.86
1933	59.79	1938	73.67

	1937	1938	1939
January	87.03	75.56	77.12
February	91.68	73.43	76.89
March	103.78	72.41	77.09
April	98.62	71.19	74.79
May	93.25	69.15	73.61
June	93.21	67.55	73.17
July	93.82	72.95	71.95
August	95.28	73.94	73.88
September	94.33	74.70	83.07
October	85.26	77.61	....
November	78.91	78.36	....
December	75.18	77.13	....

▶ZINC—Statistics for September show that production is beginning to increase, as the average daily rate of output was 1,408 tons of zinc in September, against 1,321 tons in August. Deliveries to consumers totaled 69,424 tons in September, against 49,928 tons during August. The sharp increase reflects excited inventory buying principally because of the war situation in Europe. Stocks of common grades of zinc declined 27,199 tons, the total on hand on Oct. 1 being 95,615 tons, the lowest level since January, 1938.

The July, August and September statistics of the American Zinc Institute, covering all grades, are summarized as follows in tons:

	July	August	Sept.
Stock at beginning	135,241	131,782	122,814
Production	39,669	40,960	42,225
Production daily rate	1,280	1,321	1,408
Shipments	43,128	49,928	69,424
Unfilled orders	49,379	44,773	93,116
Stock at end	131,782	122,814	95,615

Figures covering operations of the Prime Western division, for July, August and September, follow:

	July	August	Sept.
Stock at beginning	59,206	58,149	55,135
Production	17,263	17,528	18,049
Shipments	18,320	20,542	27,023
Stock at end	58,149	55,135	46,161

Non-Ferrous Metal Control in United Kingdom

Control of essential war materials was put into effect in the United Kingdom on Sept. 4. Captain O. Lyttélton has been named head of the control group for copper, lead, and zinc, and the Hon. G. Cunliffe on aluminum.

The regulations covering the major non-ferrous metals follow:

In pursuance of an order made under the Defense Regulations the Minister of Supply has undertaken the control of supplies of copper, lead, and zinc and such control will be exercised by a Department of the Ministry entitled the Non-Ferrous Metal Control.

1—The first of these orders prohibits for the time being the purchase of copper, lead, and zinc for consumption except under license (this restriction does not apply, however, to existing contracts in writing or to contracts for the purpose of enabling contracts with His Majesty's Government to be fulfilled, or to the purchase of copper, lead, and zinc for the purpose of necessary repairs not requiring more than one ton of each metal).

2—Fixes maximum prices for copper, lead, and zinc.

3—Calls for a return of information from persons concerned in the non-ferrous metal trade of stocks of copper, lead, and zinc and certain manufactures of these metals on forms which are being sent to the persons concerned. Any enquiries should be addressed to the Non-Ferrous Metals Control, Ministry of Supply, Rugby.

Export of unwrought copper, unwrought lead, and unwrought zinc and spelter and of non-ferrous scrap and old metal is being prohibited except under license from the Export Licensing Department of the Board of Trade.

Trade in aluminum is being regulated in the United Kingdom in the same manner as that established for copper, lead, and zinc.

Maximum prices fixed by the British authorities on the various forms of copper for the present are:

Rough copper, unwrought, £46, ex warehouse.

Refined copper, unwrought, in ingots, bars, etc., £49 10s., c.i.f.

Electrolytic copper, unwrought, wirebars, ingot bars, or in any other form, £51, c.i.f.

Copper billets, £55, c.i.f.

Copper cakes, £51 12s. 6d., c.i.f. English ports.

Copper cathodes, £50 10s., c.i.f. English ports.

Copper wire rods, £55, delivered.

CALIFORNIA

Gold Mines Maintaining Steady Output

Construction of new plants and rehabilitation of old properties continue—Concrete being poured for Narrows débris dam

▶ California Engels Mining Company, which started operations at the Ferris mines, 8 miles from Caliente, Kern County, about two months ago, has stepped up mill capacity from 25 to 50 tons. New equipment installed includes additional concentrating tables, a jig, and machinery to provide an increase in water supply of 30,000 gal. According to Roger L. Beals, engineer for the company, about 22,500 tons of ore has been developed, with another 18,000 tons partly blocked out, from an oreshoot 1,200 ft. long. The company is also developing the Groom mine, near Wickenburg, Ariz.

▶ Operations to place the Calaveras Central drift gravel mine of Calaveras Central Gold Mining Company, Ltd., again on a production basis are reported under way. The mine, a short distance from Angels Camp, Calaveras County, is developed by a 350-ft. vertical shaft and numerous drifts, and the surface plant includes a fully equipped washing plant. Noted drift gravel mines in the vicinity of the property include the Golden River, Vallecito Western, and others.

▶ Indian Valley Mining Company has completed and placed in operation a new 150-ton flotation plant at its Standart mine, near Greenville. Plumas County. The new unit, which replaces that destroyed by fire early this year, is of fireproof construction, and the flowsheet and equipment used follow closely those found in modern flotation mills in the State. About 40 men are now employed at the property. C. L. Hibbard, of Seattle, Wash., is president of the company, and G. L. Johnson, general manager.

▶ Rehabilitation work is in progress at the Eagle King mine, in the Grizzly Flat area of El Dorado County, where A. M. Strong and associates, of Los Angeles, are dewatering the 150-ft. main shaft with a view of exploring and later drifting under the old workings.

▶ Good progress is being made in enlarging and concreting the shaft at the property of the Stockton Hill Corporation. The work will be followed by early erection of a new 50-ft. steel headframe and a 100-ton cyanide plant. Ore reserves include 20,000 tons on the 265 level, with a similar amount blocked out on the 415 level by recent development. A drift started on this level for exploratory purposes and which has opened a vein 5½ ft. wide is to continue for 1,000 ft. Walter R. Wook, of Auburn, is president and general manager.

▶ The shaft at the property of Mother Lode Mines Company at Drytown, Amador County, is being dewatered under the direction of L. S. Wincapaw, consulting engineer, as a preliminary to a thorough examination to determine future operations. J. Foster is superintendent, and six men are employed.

▶ Work on the Narrows débris dam at Smartville is progressing according to schedule, and actual pouring of concrete is under way. A low bid of $643,450 for construction of the Ruck-A-Chucky débris dam on the Middle Fork of the American River about 18 miles from Auburn has been submitted to the United States Engineer's office in Sacramento by the George Pollock Company, of Sacramento, the estimate being $690,-566. Though the actual contract for construction of the unit has not yet been approved by Washington authorities, the contractor is reported to be making preliminary arrangements for starting work. A total of $30,000 has been made available to the board of United States Engineers and the California Débris Commission for surveys for relocation of the débris dam to be built on Bear River, which is the fourth unit required to make possible large-scale hydraulic operations in the central California mining area.

▶ Examination and development work is proceeding at the Harvard mine, at Jamestown, Tuolumne County, under option to the Alaska Juneau Gold Mining Company, P. R. Bradley, president, and some 1,300 tons of ore have been trucked to the Pine Tree, Josephine, and French properties in Bear Valley, Mariposa County, for test purposes. These holdings are operated by the Pacific Mining Company, of San Francisco, and a 150-ton flotation mill is available. Philip Bradley is in charge.

▶ Erection of a 150-ton flotation plant is scheduled to start soon at the Cherokee mine, near Greenville, Plumas County. The property is operated by A. L. Merritt, with Frank Humphrey, superintendent, in charge of operation. Hal M. Lewers, metallurgist, is responsible for the design and construction of the mill.

▶ Development of the Columbus and Mount Hope mines, near Grizzly Flats, El Dorado County, has been started by the newly organized Baltic Mines Corporation, Florian Sciaroni, president and general manager. Current work will be centered on opening the main Columbus vein and known orebodies in the lower levels of the Mount Hope. Ore obtained from this undertaking will be treated at the near-by 70-ton flotation plant of Consumnes Mines, Inc., pending construction of a 100-ton flotation mill at a later date. Electric power is furnished by the line serving the Consumnes Mines operations. A. N. Clark is consulting engineer for the corporation.

▶ A new dragline dredge capable of handling up to 4,000 cu.yd. of gravel a day has been placed in operation near Sutter Creek, Amador County, by E. A. Kent, Inc. Exploitation of the gravel holdings is estimated to be a two-year job. J. Rice is general superintendent.

▶ Arrangements are reported to have been completed by J. L. Nielsen, Grass Valley, Nevada County, for installation of a 50-ton mill at the Arrowhead mine, near Nevada City. The property is equipped with a four-stamp mill, with E. L. Nielsen in charge of operations.

▶ Gold mines reopened recently in the Grass Valley-Nevada City area of Nevada County include the Sunflower property, in the Rough and Ready district; the Coan mine, near Nevada City, and the Mary Jane mine, in the Fuller Lake district. Active development work is under way at the Sunflower and Mary Jane properties, following dewatering of the shafts, and Thomas Coan is supervising the reconditioning of the 500-ft. shaft at the Coan mine. John Blair directs operations at the Sunflower, and L. Landry and J. Murphy work the Mary Jane holdings.

ARIZONA

Operations Increased at Douglas Smelter

Higher price for copper increases employment and brings wage boost to many miners—Boriana Tungston mine and lead-zinc property of Tennessee-Schuylkill reopened

▶ Phelps Dodge Corporation commenced operations of its fourth blast furnace at the Douglas smelter about the middle of September. About 100 men will be called back to work, making employment at the smelter about 900 men. The price of 12½c. for domestic copper has stimulated production, following the usual summer quiet periods throughout the State, and early in October wage increases were granted to thousands of copper miners throughout Arizona.

▶ The Molybdenum Corporation of America, operating the Boriana tungsten mine, east of Yucca, in Mohave County, is repairing roads to the mine and will put on a force of miners to open up ore reserves in expectation of starting the mill early in October. This property was in active operation until about two years ago, when the mill burned. A new mill was built, but it never went into operation, although completed a year ago. The company has a force of about 150 men on its payroll. A small crew of men have been keeping the property in condition during the shutdown. H. L. Veatch is manager of the local operations.

▶ Men have been put to work at the Tennessee-Schuykill mine, at Chloride. The company suspended operations last January because of the low prices of lead and zinc and the uncertainty of the silver market. It is expected that production will start early in November. A supply of custom ores may permit starting the mill before mine operations commence. This property usually has a payroll of about 115 men and the mill produces approximately 30 tons of concentrates daily. Lead concentrates are shipped to El Paso and the zinc concentrates go to Amarillo, Tex. Jacob Shoder is in charge of operations.

▶ The Tyro mine, in the River range

LOOK OUT BELOW!

In driving a sewage tunnel, a 4-ton Exide-equipped locomotive somehow was dropped down a 50-foot shaft, landing on solid rock. The total damage was confined to a cracked motor support bracket, a bent axle, a broken worm housing, a slightly bent battery box and a few damaged cells. It cost only $166.50 to repair both locomotive and battery—showing how slight was the damage. We mention this very unusual accident to indicate how tough these batteries really are.

For fast haulage underground, in mining, quarrying and tunneling, you know you can rely on the speed and power provided by Exide-Ironclads. And a "freak" accident such as the one described is additional proof—if any is needed—that Exide-Ironclads stand up in hard service, keeping haulage cost low. Write for free booklet, "The Storage Battery Locomotive for Underground Haulage."

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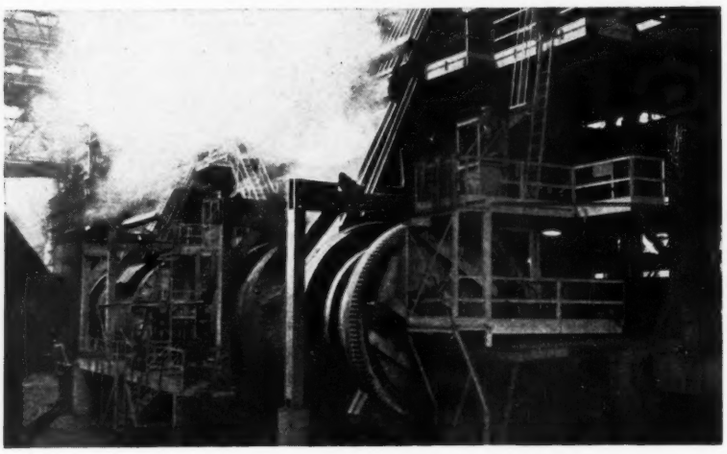


Greater demand for copper brings another 13 x 30 ft. converter into operation at the Douglas smelter of the Phelps Dodge Corporation

▶ARIZONA

north of the Oatman district, is shipping about 150 tons daily to the mill of the Gold Standard, Inc., at Katherine, which company is operating the property under lease. Richard de Smet, manager of the Gold Standard, Inc., is in charge of the operation. The property is owned by P. M. George, a Kingman business man.

▶Arizona-California Exploration Company, represented by Boston capital, operating the Pope mine, about 20 miles northwest of Chloride, has a crew of 40 men working. Ore produced is hauled by truck to the mill of the Producers, Inc., west of Chloride. The shaft is down 300 ft. and stoping is being done on both the 200- and the 300-ft. levels. The company is headed by J. O. A. Carper, a mining engineer of Denver, Colo., a well-known operator. A. H. Warner is superintendent in charge of operations.

▶The milling plant at the Cumberland mine, in the Pine Flat district near Mayer, is being rebuilt by Bassi Brothers and Vernon Taylor, who have a lease on the property. The present mill is ten-stamp, with amalgamation plates. Flotation cells are being added. The property consists of seven claims owned by William Woodburn, of Boone, Iowa.

▶Grove & Sons, of North Pleasant St., Prescott, Ariz., are shipping gold and silver ore from the Oro Flame mine, 10 miles southeast of Prescott. Grove & Sons secured a $20,000 RFC loan for the development of the property. Sufficient ore is said to be in sight for continuous operations for the next ten months.

▶The Oak Ridge mine, 8 miles northwest of Patagonia, is being operated by Virgil Turner and D. C. Kurz, of Patagonia. The mine is equipped with a hoist and a small jig. Values are in silver, lead, and copper. Ore shipments are to start soon.

▶The O'Brien group of eighteen claims owned by Mrs. W. G. O'Brien and situated near the mouth of Cerbat Canyon 10 miles north of Kingman is under lease to Harold Launsberry, of Kingman. The ore is gold-zinc complex.

▶The first run of the new mill at the Golden Belt mine, near Cordes, is reported to have been very successful. Forty-five men are employed by the Golden Turkey Mining Company, operating the property. H. C. Mitchell, of Cordes, is vice-president and general manager. O. E. Simmons is mine superintendent and Chester A. Knight is in charge of the mill.

▶It is reported that the United States Smelting, Refining & Mining Company, with headquarters at Salt Lake City, Utah, has optioned extensive acreages of placer ground in the vicinity of Quartzsite, Ariz. An extensive drilling project is contemplated in the testing operations. The drilling crew is already on the ground. F. S. Mulock is general manager.

▶Lead-silver concentrates are being shipped by the Grand Reef Mining Corporation at Klondyke, Ariz. The corporation is still treating material from the old dumps and tailings in its 100-ton plant. J. A. Gruwell, of Klondyke, is superintendent.

▶The 125-ton flotation plant of the Sterling Gold Mining Corporation at the Richinbar mine near Cordes, Ariz., is shipping concentrates to the smelter. Further exploration of the property is being done with diamond drilling. J. A. Hamilton, of Cordes, is general manager.

▶The Plymouth mine, in the Copper Basin district near Prescott, is under lease to L. Shellenberger, A. Mitchell, and Ben Eyer. The mine is equipped with a hoist, a compressor and other machinery. It is owned by Paul Donley, 230 South Montezuma St., Prescott.

▶Gus Svennson and Charles Hindman, of Wellton, owners of the Big Horn group of claims situated 9 miles south of Wellton, have leased the claims to Dr. Calvin Eaton, of Yuma.

UTAH

Wages Increased at Utah Copper

Workers at mine and mills receive 50c. boost in daily pay—Strike at Midvale smelter settled following four days of negotiations

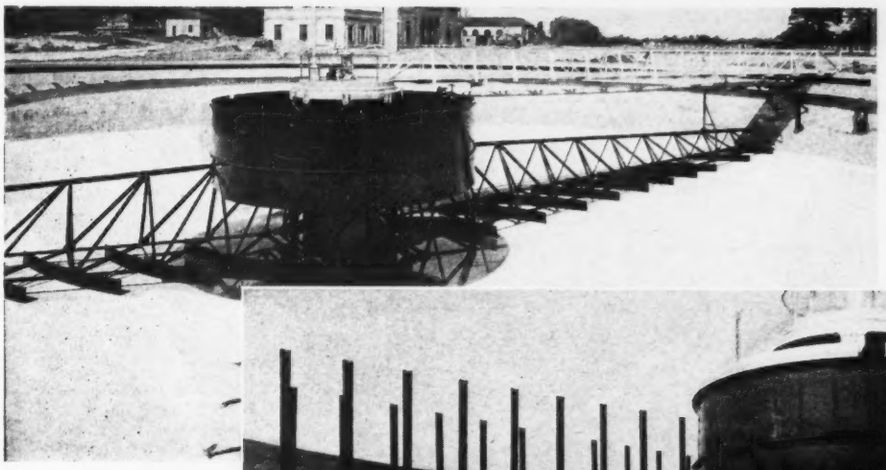
▶Effective Oct. 1, all day-pay employees of the Utah Copper Company at Bingham, Arthur, and Magna will receive a wage increase of 50c. a day. Junior-salaried employees will receive a proportionate increase, General Manager D. D. Moffat announced. This increase will swell the payroll about $40,000 monthly.

▶Employers and employee representatives joined in a series of conferences opening Sept. 21 relative to an adjustment of the Utah wage scale for underground workers and mill and smeltermen. The contract signed by both groups in 1938 stipulated that when the price of silver fluctuated from 64.64c. an ounce, a discussion should open relative to an adjustment of the wage scale adopted. Now that silver has advanced to 71.1c., the men are contending that they should have a greater share of the profits. James W. Wade, vice-president and general manager, Tintic Standard Mining Company, was spokesman for employers, and Reid Robinson, president, International Union of Mine, Mill and Smelter Workers, of Denver, represented employees. Commissioner O. F. McShane, of the Utah State Labor Board, presided. The conference resulted in a refusal on Sept. 27, by the union, to accept a 25c. daily wage rise. Negotiations, however, continued.

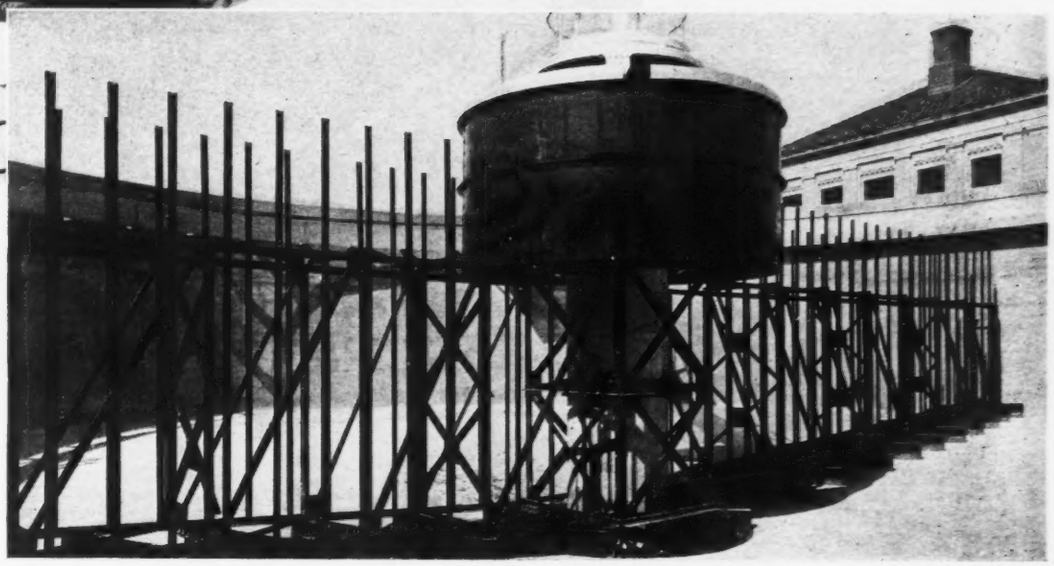
▶Five hundred employees of the United States Smelting, Refining & Mining Company returned to work at the Midvale plant on the morning of Sept. 12, after an eleven-day strike. Members of Local 331, International Union of Mine, Mill and Smelter Workers, unanimously voted to accept the contract offered by the company. Union demands for a closed shop were refused by the management, but a satisfactory seniority clause and an agreement to keep the plant on a five-day working week basis during productive operations were obtained by the union. Settlement of the strike came after four days of negotiation between officials of the plant and a union committee. Frank P. Ashe, national labor relations board conciliator, attended the sessions in an advisory capacity. A. M. Petersen, state president of the CIO organization, represented the men, and F. S. Mulock, general manager, the United States Smelting, Refining and Mining Company.

▶Improvement was noted at Park City, where the Park Utah Consolidated Mines went on a partial two-shift basis on Sept. 5. About fifty men were employed at the mines. Augmented operations will continue, announced General Manager O. N. Friendly, so long as there is no decrease in metal prices and no increase in the cost of operation.

ANNOUNCING
THE DORR PICKET THICKENER



Left. Dorr Thickener with conventional type of rake.



Right. Dorr Thickener equipped with the new "picket fence" type of rake.

FOR BETTER THAN NORMAL SLUDGE DENSITIES

The mechanism looks like a "picket fence" and that's how it got its name—The Dorr Picket Thickener. Very much the same type of raking mechanism, to be sure, but studded with rows of vertical steel members or "pickets," channeling through the zones of sludge compression and releasing water occluded between the individual particles.

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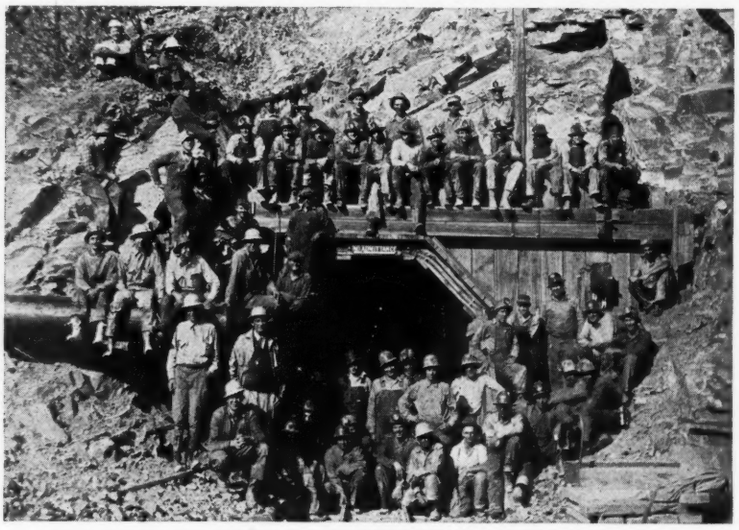

Rapid progress in the Carleton Drainage Tunnel, in Colorado, is credited to this drilling crew, its supervision, and to the use of mechanized equipment

COLORADO

Tungsten Mines Stirred By Greater Demand

Deposits in Boulder County again attract interest as European war influences higher prices for metal—Mining activities in other districts expected to increase

▶ The tungsten mines of Colorado have become more active because of the war in Europe. Demand has increased in the domestic market and shipments are greater. J. G. Clark interests, the Vanadium company, and the Wolf Tongue mine account for most of Boulder County's output. The last two companies operate their own mills. Several small mills, such as the Carl Egle, the Walsh, and the Betasso, are operating continuously. The Conger tungsten mine and mill of the Vanadium Corporation of America are milling 45 to 50 tons per day, and with the reserves blocked out and developed, should permit continuous operations during the winter months. Only recently a shipment of 25 tons of 55 per cent concentrates sent to the city of Washington, in Pennsylvania, was valued at nearly $20,000. Robert Sterling is manager of the company's operations in Colorado.

▶ Other active mining operations in the Boulder-Gilpin County section include: The Star mine, near Rollinsville, shipped two cars of gold ore during September. George D. Hilding and Associates are unwatering the St. Louis mine, near Caribou, installing electric power, a hoist, an air compressor, and reconditioning the mill. A Chicago group has acquired the Anchor mine, west of Caribou, and is reopening the workings. Gamble Gulch Mining & Milling Company is being refinanced by Eastern interests and the property is expected to be reopened. The Ward United Mines Company, operating on the Utica property, has completed the shaft to the orebody, according to J. E. Emmons, manager of operations.

▶ The Alma-Fairplay district has produced a new gold strike, that has aroused interest, in the Consolidated Montgomery mining area. The ore, according to the discoverers, measures 8 ft. wide in a well-defined fault traced for a considerable distance through Mount Lincoln, on the south side of Alma. A drift has been driven some 60 feet in the vein. Dennis E. Stump Jr., P. O'Neill, and John O'Neill made the strike.

▶ The New Carlton Drainage tunnel, in the Cripple Creek district, is progressing rapidly and its completion is expected within three years. The portal of the new tunnel is at an elevation of nearly 7,000 ft., whereas the portal of the old Roosevelt tunnel is 8,033 ft. above sea level. The tunnel is being driven on a 3 per cent grade. Under the direction of A. H. Bebee, vice-president in charge of mining operations, and the supervision of John A. Austin, superintendent, some tunnel drilling records are being broken. A powerful ventilating system has been installed, to permit operations soon after blasting. Shoveling, loading, and haulage is mechanized.

▶ According to the latest report of Charles W. Henderson, chief engineer of the United States Bureau of Mines, and A. J. Martin, Colorado produced gold, silver, copper, lead, and zinc in 1938, valued at over $22,000,000 and only $33,000 less than in 1937. Over 58 per cent of the value was from gold production. Silver and copper produced increased nearly 30 per cent; but because of the lower metal prices in 1938, the value increase amounted to about 6 per cent over 1937 figures.

MONTANA

C.I.O. Miners Union Vote Not To Strike in Butte

Demands include a flat 20 per cent wage increase by Anaconda Copper Mining Company—New wage basis proposed by company is accepted by all unions

▶ The contract between the Anaconda Copper Mining Company and various craft and trade unions associated with Montana operations expired on Oct. 1. Notice was given on May 16 that the contract that has been in existence for the last two years would not be renewed by the unions and that new demands would be presented by several groups. On Sept. 11, Anaconda announced a revised wage schedule to become effective to each group immediately upon notice of acceptance, based upon a two-year contract.

On Sept. 18, announcement was made of acceptance by all craft unions in Butte, Anaconda, and Great Falls, members of the Building Trades Department and Metal Trades Department of the American Federation of Labor. Similar acceptance by Smeltermen of Great Falls and Anaconda was announced on Sept. 21. The Butte Miners Union, however, after rejecting the above proposal, registered a strike vote on Sept. 20 by a vote of 1,447 to 2,229, to become effective on Oct. 1, unless demands were met by Anaconda in the interim.

Following this action, negotiations continued and minor concessions, including grievance committees and adjustment of contract rates in proportion to the general wage increase on a day's pay rate instead of a flat bonus, were made by the company. This action required a second referendum vote that occurred on Sept. 30, resulting in acceptance by the Union of the company's revised contract. Therefore the strike vote previously taken was cancelled. Points discussed and not allowed were collar to collar 8-hour day and a flat 20 per cent pay increase.

▶ W. S. Norman, president of Butte Highlands Mining Company, reports that the company earnings in terms of gross mint returns for the first six months of 1939 were $205,034, during which time 9,967 tons were treated. This indicates a gross recoverable value of $20.57 a ton, which according to records is a 96.94 per cent recovery.

▶ It is reported at Columbus that the stockholders of the Chromite Products Company, which controls the Benbow group of claims, has entered into an agreement permitting the United States Bureau of Mines actively to develop the property under provisions of recent war material legislation. It is stated that Paul T. Allsman, of the metal division of the Bureau, will be in active charge of the work. In connection with the same general program it is reported that Dr. Pardee and other representatives of the United States Geological Survey are studying manganese deposits of Phillipsburg and Butte.

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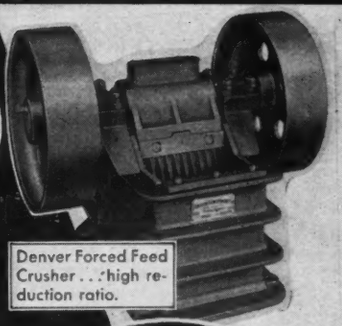

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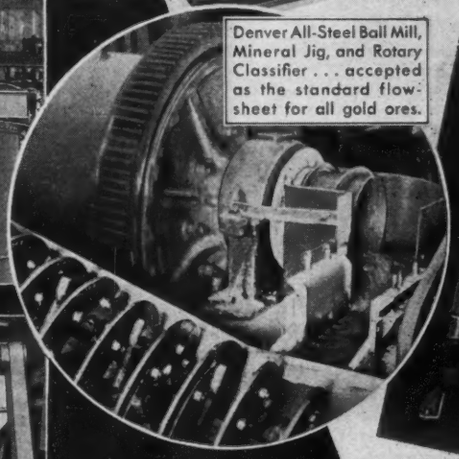

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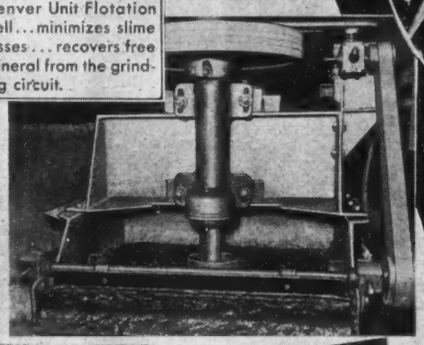

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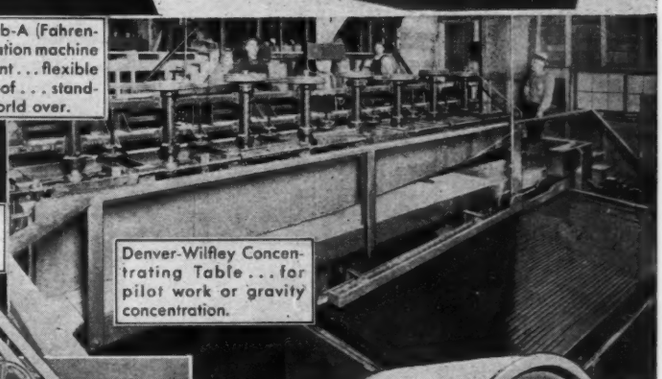

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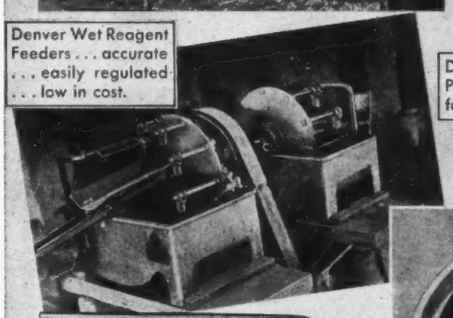

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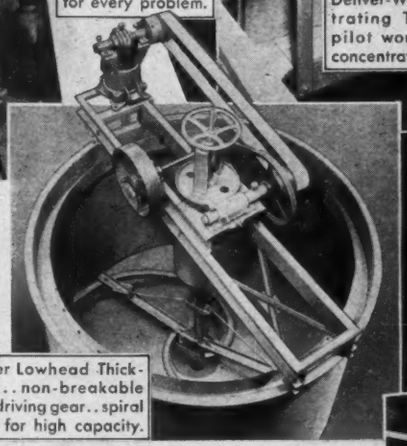

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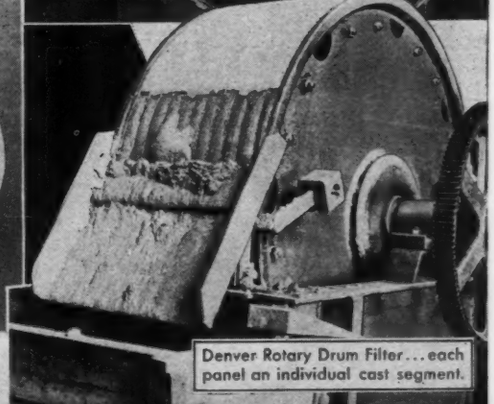

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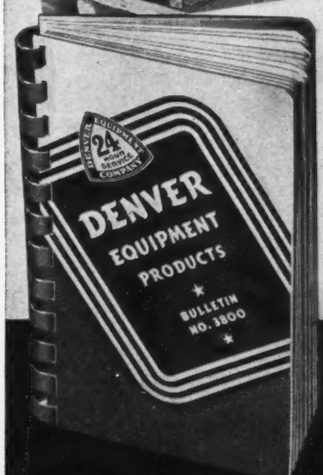

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NEWS FROM Washington

By Special Correspondent

NEUTRALITY arguments exhibit radical differences of opinion as to the way in which the United States can be kept out of the European war. Even those who sound most literalistic appear at close range in Washington to be sincerely trying to the best of their ability to achieve that important goal. The differences are as to the methods of keeping out of war, not whether we should or not keep out.

An amazingly small part of the total controversy roots in a desire to make personal or party capital out of the situation. As usual, it is not good politics to be very partisan in such an international affair.

Is War Imminent?

The military departments of the Government are under orders to proceed on the assumption the United States may be embroiled within six months. This does not mean that the President really expects any such contingency. But it does mean that he and all of his advisers recognize that being ready to go in, should the nation be forced to extreme action, is the best way in which to save American lives and property.

Industrial leaders are being urged to proceed on a similar assumption in so far as preparatory and precautionary measures are concerned. Here again, any panicky militaristic spirit is definitely avoided. The least wanted of all is any appearance that because war may be imminent, any company is doing this or that in order to be profitably situated. There will be some of this latter appearance, Washington executives realize. But they hope to keep it at a minimum.

Two Mineral Controls

DEPARTMENT OF INTERIOR officials continue to press for further Federal control of all minerals. The nose of the camel is entering the industry tent in the form of contemplated legislation for petroleum regulation. But the more frank spokesmen of Mr. Ickes' Department and of the National Resources Committee believe that further "Governmental control of metal development on privately owned land has been very slow in emerging." And they almost categorically state that they intend to correct this matter of regulation as soon as Congress will permit.

It is expected that the Interior Department will make quite a play for full petroleum control authority during this coming winter. The necessity for this during an emergency period of military activity will, of course, be played up to the maximum. Career executives of the Government who believe in private ownership are genuinely disturbed at the trend because they realize that it is only a step from petroleum to coal and another short one into the whole metal and non-metallic mineral field. Even those units which have no interest in petroleum are expected to take an active part in opposing the new legislation when it comes before Congress during the emergency or regular session of the winter.

In their effort to limit Federal interference with private industry activity, spokesmen of business are being urged carefully to distinguish between the Ickes plans and those types of controls which will be necessary under a War Resources Board activity. Although plans for possible war-time management and allocation of supplies are being generally accepted, there appears to be no reason for assuming that they need have any permanence beyond the time of military emergency. As a matter of fact, it is rather expected that Congress is as keen as anybody else to have military authority of dictatorship type, which may be needed temporarily, so granted as to terminate automatically when the emergency itself ends. Those who recall the difficulties of getting rid of emergency agencies after November, 1918, as many Congressmen and most Senators do, will know why this phase of terminating emergency legislation will not be overlooked.

Early in September the broad plans for the mineral controls of possible war time were laid through further action of the Stettinius board, whose formation and broad plans were described in these columns a month ago. The type of men chosen and the general instructions given them, though not published, are well enough understood outside of official circles to be very reassuring to the mineral industry. Sympathetic, practical businesslike understanding of mineral control in war time can reasonably be expected.

Lake States Iron

IN ONE of its regional planning reports, the National Resources Committee expresses what appears to be an official interpretation of the Department of Interior staff and its economic advisers regarding the fundamental problems of iron mining in the Lake Superior region. That philosophy in the words of the recently published report is:

"Iron mining is the leading industry in dollar value in the Region. The Lake Superior district is at present the most important iron-ore producer in the United States, accounting for 85 per cent of the 1937 national production. Keeping the district in its foremost rank for an indefinite time, stabilizing employment, and a more wise and careful exploitation than has been practiced in the past are the major problems as far as the Region is concerned.

"Employment in this industry has been decreasing due to completion of much of the preliminary work, the increase of open-pit mining, and the advance of technological developments. Most of the open-pit labor is idle during the winter months, and winter employment in the underground mines is not encouraged by the present personal-property tax on inventories.

"The adjustment of the present tax systems, the continuation of exploration, and the increased use of beneficiated leaner ores offer the best opportunities for stabilizing employment, meeting competition from foreign sources, and for extending the life of the district indefinitely into the future. Continued and accelerated progress in beneficiation, in particular, points to an optimistic future. The Federal and State Governments and the mining companies are coresponsible." (The italics of this paragraph were those of the official report.)

Tungsten Purchase

PURCHASE by the Government of tungsten ore is being arranged simultaneously in two ways. Procurement Division purchases are described in another column. The Navy Department has been using some of its funds available for similar purpose and made a contract Sept. 20 for the purchase of 17,520 short-ton units of tungsten ore at $25 per unit.

Some bitter criticism of the Navy policy has resulted. The reason for this is evident from the nature of the two bids which had to be considered. The successful bidder was a sales representative of an American mining enterprise. He offered ore at $25 per short-ton unit, f.o.b. Brooklyn, with the plan to supply this from stocks already above ground, it is reported. The unsuccessful bidder was the representative of a Chinese firm which offered to import ore of 65 per cent WO_3 minimum content at $15.75 per short-ton unit in bond, c.i.f. New York.

In rejecting this much lower bid, the Navy took into account the fact that the duty on this ore would be $7.93 per unit, making the gross cost $23.68. Critics are very caustic in remarking that this is bad reasoning, since in any event the duty goes immediately back into the Treasury, assuming that the Navy must pay it even as a bookkeeping matter. The Navy of course explains that it took the higher bid under the "Buy American" law which gives certain bid advantages to American producers.

Critics point out that nearly two-thirds more tungsten could have been put into stock with the same money if the foreign ore had been accepted. They also emphasize that the American ore was already in the country, amounted to a military reserve where it was, and that the purchase by the Navy simply takes the money out of the Treasury without actually creating any new element of preparedness.

"Stockpile" Bids

THE FIRST FIVE requests for bids made by the Procurement Division of the Treasury under the "stockpile" act are for mineral reserves. Two relate to manganese ore, two relate to chromium ore, and one relates to tungsten ore. It is expected that other items later will apply to mineral commodities also.

The first five requests are for purchases of ores for which the specifica-

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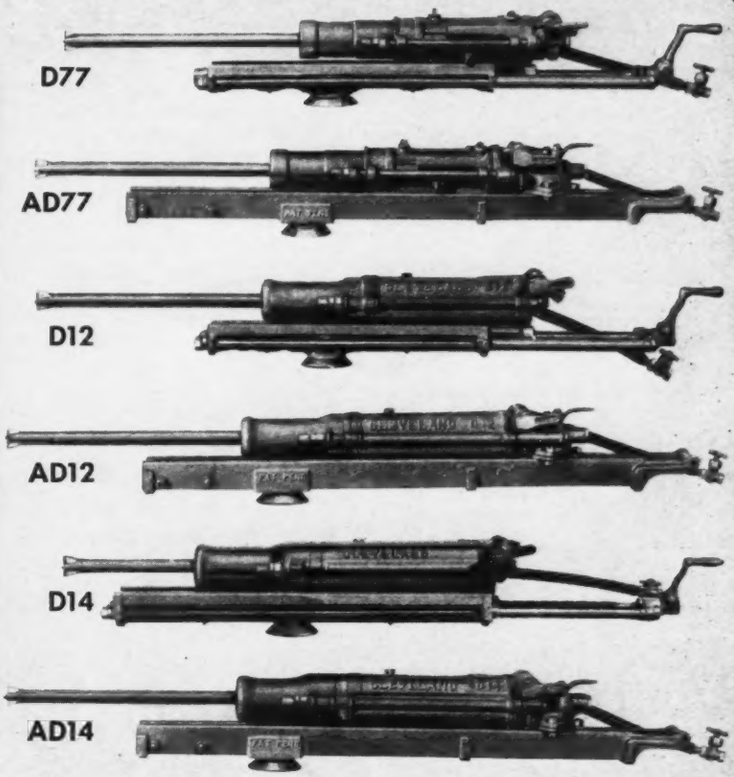

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LEADERS IN DRILLING EQUIPMENT

tions are presented herewith on this page. It will be noted that no sacrifice of quality specifications has been permitted as a favor to domestic producers. The military and civilian authorities are insisting that the real purpose of the stockpile demands that these high-quality ores be purchased.

There are, however, in the bid forms arrangements by which American producers can conveniently meet the Government requirements if they are capable of supplying the grade of ore demanded. The ladder system of offerings is used, permitting the company to supply any small quantity of ore which it may wish to furnish on a basis strictly competitive with larger suppliers and importers. Under this scheme, the Government can allocate its purchases to several different companies in accordance with price and other considerations important to the national defense.

Still another convenience for American producers is provided in allowing deliveries of part of the ore to be made at the Army Ordnance Depot, Ogden, Utah, if preferred by the bidder. That eliminates the large disadvantage in freight which Western producers would otherwise experience. The bulk of the imports is, however, expected to be taken by the Government at Baltimore for manganese; New Cumberland, Pennsylvania, for chromium; and Columbus, Ohio, for tungsten.

To avoid the contingency of having offerings of ore made from stocks already in this country, the Treasury requires that imported ore must be newly imported or at least not now in the country in bond. There is not a comparable provision regarding domestic production, but it is understood that the Treasury does not wish to accept stocks above ground in the United States, either those of domestic production or those which have been brought in and duty paid in the past. To do so, they rightly conclude, would largely defeat the purpose of this spending, which is to enlarge the available supply of material within reach of the United States in case of an emergency.

Bids on the two schedules for manganese ore will be opened Oct. 19 and on the three schedules for chromium and tungsten ore Oct. 20.

Export Limitations

TO PROTECT SUPPLIES of mineral commodities already in the United States against excessive depletion, Government officials are attempting to work out new rules. Some of these will amount to civil restrictions on exports if the President and Congress agree with the theory now being advanced. This theory might even go so far as to preclude export without license of such a thing as canned peaches because the cans would carry much of the needed reserve of tin out of the country. That admittedly is, however, rather an extreme illustration of the problem being studied.

This is the reason that the Government men are worried. They anticipate a boom in industrial activity. Much of this will be due to purchase orders of foreign governments and foreign enterprises which buy from the United States to augment depleted supplies at home.

Treasury Department Procurement Division Specification For Tungsten Ore

Scope This specification covers one grade of tungsten ore.

Grade The tungsten ore shall be as required by the following paragraphs.

Detail Requirements

(a) Tungsten ore shall be furnished in lumps or fines, or a mixture of both.

(b) Tungsten ore shall conform to the following requirements as to chemical analysis

Tungsten trioxide	WO_3	60% minimum
Tin	Sn	1% maximum
Copper	Cu	0.05% maximum
Phosphorus	P	0.035% maximum
Arsenic	As	0.50% maximum
Antimony	Sb	0.05% maximum
Bismuth	Bi	0.12% maximum
Molybdenum	Mo	0.40% maximum
Sulphur	S	0.50% maximum

Packaging, Packing and Marking for Shipment

(a) **Packing**—Tungsten ore shall be delivered in heavy oak barrels or suitable steel drums. The total weight of the ore and the container shall not exceed 500 pounds.

(b) **Marking** — Barrels and drums shall be marked with the name of the article and the quantity contained therein, the contract number and the name of the contractor.

Approved August 24, 1939
(Signed) H. E. Collins
Director of Procurement

Treasury Department Procurement Division Specification For Manganese Ore, Ferro Grade

Grade (a) There shall be three grades of manganese ore, suitable for the manufacture of Standard Ferro-Manganese, Grade B, Federal Specifications QQ-F-161, by the usual commercial methods of manufacture, conforming to the requirements as stated below.

(c) Preferably, all ores should pass a 4-in. screen and contain a minimum of fines; however, no ore will be accepted which will not pass a 6-in. screen, nor which contains more than 12½% of fines which will pass a 20 mesh screen.

Quality The seller shall furnish a complete analysis of the ore he proposes furnishing, giving the guaranteed minimum manganese content and the guaranteed maximum content of iron, phosphorus, silica, and alumina.

Approved August 24, 1939
(Signed) H. E. Collins
Director of Procurement

(b) Composition on a Dry Basis

Grade	Manganese Minimum	Iron Maximum	Silica Maximum	Phosphorus Maximum	Alumina Maximum	Zinc Maximum
A	48%	7%	9%	0.12%	3%	1%
B	48%	*7%	**10%	0.18%	6%	1%
C	48%	7%	7%	0.15%	6%	1%

*Grade B iron content to be not less than 1%.
**For each additional percent of manganese content over 48% an additional 0.2% silica content allowable.

Treasury Department Procurement Division Specification For Chromium Ore

Grade This specification covers one grade of chromium ore.

Material and Workmanship The chromium ore shall be as required by the following paragraphs.

General Requirements See Detail Requirements.

Detail Requirements

(a) Chromium ore shall be furnished in lumps. All lumps shall pass a 6-in. screen. Not more than 10 per cent shall pass a ½-in. mesh sieve.

(b) Each shipment of ore shall be suitable for the manufacture of ferro-chromium (all grades except "A") in strict accordance with Federal Specification QQ-F-151, by the usual commercial methods of manufacture, without blending with other ores.

(c) The chromium ore shall be of the composition shown in table below.

(d) All chromium ore delivered on a single contract shall be of the same average chemical analysis.

(e) All cars prior to loading with ore shall be broom swept free from sand or any other foreign matter. All leaks shall be caulked tight to prevent loss in transportation.

(f) All tare weights of cars shall be actual weight of clean cars. Stencil weights will not be accepted in determining the delivered weight.

Approved August 24, 1939
(Signed) H. E. Collins
Director of Procurement

Element	Percentage
Chromium oxide (Cr_2O_3) (minimum)	48.0
Iron (metallic) (maximum)	½ of the actual percentage of chromium (metallic)
Sulphur (maximum)	0.50
Phosphorus (maximum)	0.20

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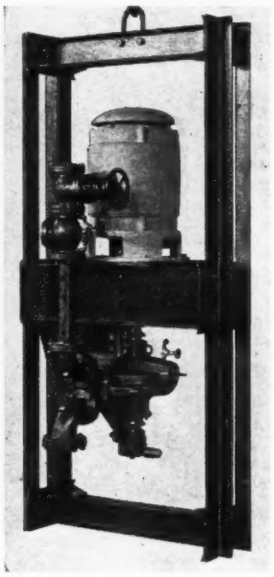

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NEVADA

Active Development at Owyhee River Copper

Property adjoining the Rio Tinto is reported to be mining a good grade of copper ore—New Cyanide plant of Northumberland Mining Company completed

▶ Three shifts of miners are engaged in development work on property of the Owyhee River Copper Company, adjoining the Rio Tinto mine of the Mountain City Copper Company in Elko County. A crosscut tunnel is said to have opened a 60-ft. width of ore sampling up to 3.8 per cent copper and ore at another point was reported to sample as high as 12 per cent. The claims were among the first located for copper in the district by S. Frank Hunt, discoverer of the Rio Tinto mine. James Hooper is manager.

▶ A newly constructed 300-ton cyanide mill is nearly ready to treat ore on property of the Northumberland Mining Company on the Monitor valley slope of the Toquima range in northern Nye County. The low-grade gold orebody is composed of a mass of silicified, blocky schist, dipping around 30 deg. with the slope of the hill, permitting open-cut mining by power shovel. The mill equipment was nearly all taken from the similar plant at Weepah, Esmeralda County, operated with marked success by the Weepah-Nevada Mining Company. The same group, composing the new Northumberland Mining Company, includes Walter Haggerty, of Beverly Hills; and Coleman F. Madden and Sam H. Harris, of New York. J. C. Perkins, manager, maintains an office at Tonopah.

▶ Reorganization of the Ambassador Gold Mines, Ltd., with a large area of placer ground in Lyon County, under the new Sec. 10, formerly 77b, of the Federal bankruptcy act, is in progress in the Federal district court at South Bend, Ind., main offices of the company being at Laporte, Ind. New capital structure is involved, with an exchange of Class A shares for outstanding bonds. Some personal property was sold by order of the court, but title is retained to placer deposits covering 66 claims, together with a 240-acre farm with buildings and several flowing artesian wells. Frank C. Olive, an Indianapolis attorney, has been in Nevada in connection with reorganization.

▶ A new orebody, with 8-ft. width and indicated to be of high mill grade, has been opened above the main adit of the Mary mine of the Black Mammoth Consolidated Mining Company at Silver Peak, in Esmeralda County. F. A. Vollmar, Jr., is president. Part of the mine is operated under lease, with a 300-ton flotation-cyanide mill, by the Prescott lease, owned by E. L. Cord, retired motor and airplane manufacturer. Arthur N. Sweet is manager.

▶ A contract for a 75-ton all-slime countercurrent cyanide plant for the Summit King Mines, Ltd., in Fallon, has been awarded to the Southwestern Engineering Company, Los Angeles. A 3.8-mile pipe line with pumping plant will be installed to furnish water for mill operation and a 200-kw. diesel-electric plant.

▶ Bullion receipts for the first half of the current year by the Dayton Consolidated Mines Company, operating mines and a 150-ton cyanide custom mill near Silver City, Lyon County, were $347,725.99 from 21,931 tons of ore that included 8,371 tons of custom ore trucked from points as far as 200 miles distant, the remainder being from the Dayton mine and the leased Keystone and Justice mines. Metal recovery was approximated $16 per ton, and net operating profit was $18,300.47 before depreciation, depletion, and Federal taxes. Denver Equipment Company jigs were installed lately in the cyanide mill, and the company has leased the flotation mill of the South Comstock Gold Mines, Inc., to treat ore of the Keystone mine.

▶ In the Gregg Basin district, in eastern Clark County, the Lake Shore Gold Mining Company has completed and is operating a 200-ton cyanide mill on gold ore from a surface bedded deposit in altered granite. The ore is mined by power scraper and is delivered to the mill by Caterpillar carryall. Diesel power is provided for the mill. E. G. Frawley is in charge of company headquarters at Las Vegas, Nev.

IDAHO

Operations Resumed at Star Zinc Mine

Property closed since February, 1938, will reemploy about 350 men—Miners in Coeur d'Alene district receive wage increase

▶ The Star zinc mine, owned jointly by the Hecla and Bunker Hill & Sullivan companies, resumed operations the week of Sept. 15 and will employ up to 350 men as operations increase. It is operated from the 2,000-ft. level of the Hecla shaft through a two-mile crosscut. The mine is equipped with a modern concentrating mill and the product will be treated at the Sullivan electrolytic zinc plant at Kellogg, which has already stepped up operations to a full-time basis. The big plant has been working on a half-time basis the past year.

▶ The lead-silver mining companies of the Coeur d'Alene district have increased the prevailing wage scale 50c. per working shift following increased metal prices. About 3,000 men will benefit by the increase at the Morning, Page, Jack Waite, Hecla, and Bunker Hill. Timbermen will receive $6.75, miners $6.25, and muckers $5.75.

▶ The recently incorporated Mines Engineering Corporation has elected a board of directors composed of James F. McCarthy, general manager of the Hecla; and James E. Gyde, Jr., both of Wallace; Stanly A. Easton, president of the Bunker Hill & Sullivan, of Kellogg; Thomas R. Jones, president of the Wardner Weber Bank, and Robert C. Moffitt, of Seattle. The new corporation has en-

tered into a contract with the Silver Summit Mining Company to complete an additional 1,000 ft. of shaft in the Summit property. Sinking will be started immediately from the 700-ft. level under the direction of Harry P. Pearson, general manager of the Silver Summit. Twenty miners are employed in the shaft, which is one of the largest and best equipped in the silver belt, a vertical three-compartment 10x20. Progress is being made at the rate of 5.3 ft. of timbered and completed shaft per day.

▶ An interesting deposit of cobalt is being developed by the Uncle Sam Mining & Milling Company in central Idaho, southwest of Salmon City. Ore samples are reported to assay 2 per cent cobalt, $28 in gold per ton, and 1.3 to 11 per cent copper, plus some nickel. The cobalt will be shipped to a refinery at either Buffalo or Cleveland.

▶ Quartz Creek Gold Dredging Company has started operations near Pierce City, in central Idaho, where it has 5,000,000 cu.yd. of available ground for dredging. The dredge will handle about 80,000 cu. yd. a month with fifteen men employed.

▶ Clayton Silver Mines, in Custer County near Clayton, recently shipped two 30-ton cars of ore which netted the company $6,268.28. In the first six months' period of 1939 the company produced 704,522 tons of crude ore and concentrates, which netted $60,796.04. Production was divided into 948,945 lb. of lead, 63,535 oz. of silver, 9,528 lb. of copper, and 14 oz. of gold. Milling capacity will be increased and a power plant installed if ore development on the new shaft level comes up to expectation. H. B. Kingsbury, of Wallace, is president.

▶ Gordon Prentice, of Seattle, has purchased the Painter Homestead and Surprise group of mining claims, on the Salmon River south of Dixie. Work will be started immediately with a crew of ten men.

▶ Coeur d'Alene Mines Corporation, in the silver belt east of the Sunshine, struck a vein of high-grade silver ore on the 2,400-ft. level on Sept. 20 which promises to be the most important silver discovery in the district since the opening of the deep Sunshine orebodies. The vein had widened to 6 ft. with assays showing 164 oz. of silver and 7 per cent copper to the ton. During the past several months the mine has been producing 60 tons of ore per day.

▶ The Moe mining property, west of Mullan, has resumed development work, manager Harry P. Pearson, Wallace, reports. Former work opened a large siderite vein carrying silver-copper values.

▶ An important discovery of gold ore in the old King mine, near Silver City, has been made by Carl Haacki and Harvey and Tom Curtis, all of Mullan. A vein was opened in the old tunnel which assays about $65 per ton in gold.

▶ The Viking Dredging Company, of Chico, Calif., recently placed a drill on the North Fork near Gibbonsville, to test ground for dredging. Lewis Ralph, of Weaverville, Calif., is managing the work.

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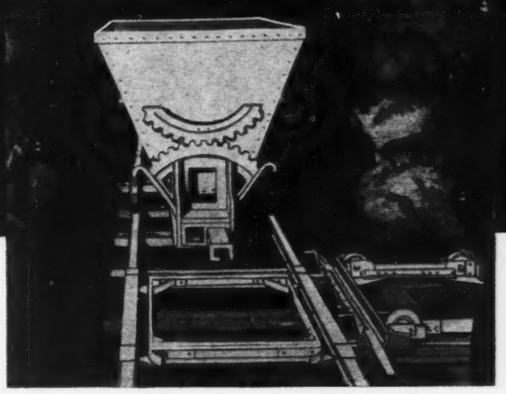

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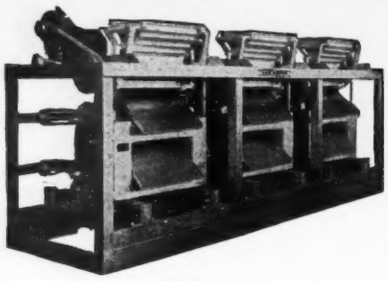

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TRI-STATE

Several Zinc Mines Being Reopened

Price of zinc concentrate, which advanced from $31.50 to $44 per ton, brings higher wages for miners—Increased ore production may be slow, due to mine rehabilitation

▶ The recent upturn of zinc concentrate prices from $31.50 to $44 per ton, due to the war in Europe, has brought with it an increase in miners' wages of from 75c. to $1 per eight-hour shift. The dicerence in wage increase is caused by the fact that in one case every $2.50 change in concentrate prices causes a corresponding 25 cent increase in wages, whereas in the other the wages are changed 50c. for every $5 concentrate price change. When concentrate prices dropped below $30 in the fall of 1937 the companies on the $2.50 schedule maintained their $32.50 base wage and the other companies maintained the $30 base wage, to which they had dropped when concentrates dropped below $35.00.

▶ Due to the recent increase in zinc concentrate prices, wages of mine employees have been raised $1 per shift. Machine men (miners) now receive $5.05 per shift and unskilled underground laborers $4.30 per shift. One major company has increased operating time to six shifts per week in the mines, paying the men time and one-half for all time over 44 hours. Approximately 1,000 new men will be employed in the district by the middle of October, due to the increased demand for concentrates.

▶ Kansas Explorations, Inc., a subsidiary of St. Joseph Lead Company, will resume operations at their Ritz mill west of Cardin, Okla., and Jarrett mill north of Picher, Okla., early in October. Ross Blake is district manager for the company.

▶ The fruits of several years of low prices are becoming apparent in the Tri-State district, for with a persistent and growing demand production is slow to respond. Practically no new ore reserves have been developed since 1929 and the known reserves are rather limited. Some low-grade reserves can be mined under the present prices, but it will take several weeks or months to bring them into production. Several major companies are considering reconditioning mills which suspended operations in late 1938 or earlier, but plans are not definite as yet.

▶ Operations were resumed Sept. 15 at the New York tailings re-treatment mill of the Cortez-King Brand Mines Company in the southeast part of Picher, Okla. Tailings from the Craig land one-quarter mile to the south will be re-treated. Approximately 25 men will be employed according to Dewey Sims, superintendent.

▶ The Eagle-Picher Mining & Smelting Company is carrying forward plans for reopening several of its mines, among them being Bird Dog Nos. 14 and 32, John Beaver No. 1, and two shafts on the Southside. Ore from these mines will be treated over the Central and Bird Dog mills of the company. About 150 men will be employed.

▶ The St. Louis Smelting & Refining Company started a program of development work at its mines in the Waco camp several weeks ago, but with the sudden upsurge in concentrate prices this program is being rushed so that sufficient ore can be developed to start up the new 50-ton per hour concentrator, which was completed early in 1938 but never placed in operation. H. H. Utley is district superintendent.

▶ Davis-Big Chief Mining Company is reopening several mines on leases from the Eagle-Picher Mining & Smelting Company. All ore from these mines will go to the Central mill of the latter company. C. E. Niday, superintendent, reports about 40 men will be employed.

▶ Federal Mining & Smelting Company

will resume operations at its Jarrett mill west of Treece, Kan., soon after the first of October, according to L. G. Johnson, district manager.

▶ Eagle-Picher Mining & Smelting Company is repairing two shafts on the Grace Walker mine, south of Picher, and one shaft on the Benny mine, south of Cardin, Okla., preparatory to resuming mining operations early in October. The Wingfield shaft south of Oronogo, Mo., is also being reopened. Ore from the last-named shaft will be treated at the American mill of the company north of Oronogo; and ore from the other shafts will be treated at the Central mill near Commerce, Okla.

▶ Iron Mountain Lead & Zinc Company is carrying on development work at its Empire mine, north of Hockerville, in Kansas, and will resume operations at the mill if sufficient ore is developed. George B. Cox, of Joplin, is president of the company.

Head of St. Joseph Lead Speaks To Miners

▶ At a "family party" of the employees of the St. Joseph Lead Company, at Bonne Terre, Mo., Sept. 16, Clinton H. Crane, president, analyzed the present situation in lead and again emphasized that a famine in lead in this country is not likely to occur. In Mr. Crane's opinion, war uses of lead are less than the peace uses. His views on lead are summarized as follows:

"In 1914, the United States produced one-half the lead that was produced in the world—we produced 550,000 tons and the total world output was 1,100,000 tons, in round figures. In 1938, United States production was 385,000 tons and the total for the world was 1,700,000 tons. That means that in 1938 the United States produced one-fourth of the world's total. In 1914, the British Empire, including Canada, Australia, and Burma, produced 140,000 tons. Last year, they produced 600,000 tons. Mexico produced 100,000 tons in 1914 and last year 300,000 tons. I do not believe that the British Empire can use anything like 600,000 tons of lead a year.

"At present all markets are upset. The first thing the British did was to commandeer all Empire lead at a fixed price of £17 3s. per long ton, which is about 3c. per pound at the present rate of exchange.

"A great deal of Mexican lead can come into this country under certain conditions paying 1½c. per pound duty on lead in ore (the pig lead duty is 2⅛c.) and net them more than they can probably get abroad.

"So I don't think any of us here have any reason to expect a famine in lead. I think 5½c. is a fair price under present conditions, although in war times, you can't look too far ahead. We here should be happy to run at our present full-time production of five days a week, which is, under the present law, full time, and be able to sell that production at 5½c. The Company's policy as regards stocks has been not to sell stocks except when the district is running full time. Stocks are built up in slack times for the sake of keeping the district running.

"During the last two weeks, we have gone into these stocks to the extent of 15,000 tons more than we were producing, but I feel that is a temporary situation. A runaway market would hurt all of us. There is nothing to a high price for a few days—it is no benefit to this district as it would prevent the normal uses of our lead in paint, cables, and other products. We must see to it that our customers can continue to operate on a satisfactory basis. A very much higher price for pig lead means a further displacement for uses of lead.

"When lead went to 5c., production in the United States increased about 6,000 tons a month; from about 32,000 tons to about 38,000 tons. Five and one-half cents will probably increase it even more, but below five cents there are many producers

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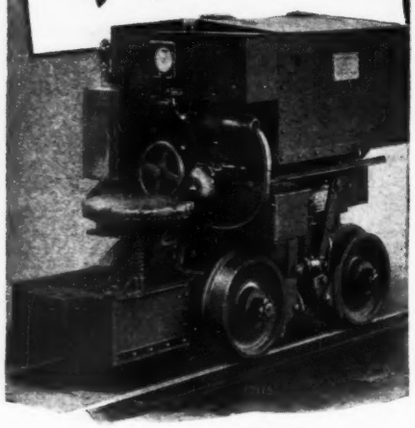

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▶TRI-STATE

who cannot make any money. Of course there are no mines in this country that can make any money at 5c. and lay aside necessary reserves for continued operations. You all realize that no mine is everlasting. St. Joe is doing what it is doing today because, from time to time, it has bought other properties and other ore reserves. In order to continue to operate successfully, this must be the policy of any mining company.

"I am willing to look forward into the winter, but beyond that I don't think anybody can predict what will happen. I confidently expect to see a falling off in the demand for our product. The trade situation will adjust itself and consumers will cease to feel that they can't get lead. Of course, this depends on whether there is a real improvement in business in the United States."

IRON COUNTRY

High Steel Production Boosts Iron Ore Output

Shipments to Lake Erie ports sharply increased, and a total of 42,000,000 tons is expected during season

▶Preliminary estimates of shipments from the Lake Superior district indicate that about 42,000,000 tons will be shipped during the 1939 season. On Sept. 1 over 22,000,000 tons had been shipped from the various ore docks, and the estimate for September and October is 8,000,000 tons per month and about 4,000,000 tons for November—making a total of 42,000,000. Steel production is increasing, and mining companies have received increased schedules for iron-ore output. The Mahoning mine, at Hibbing, Minn., had a schedule of 1,000,000 tons until late in August, when this was increased to 2,000,000, and several other smaller additions have been added on to all the various companies in the mining field.

▶Consumption of iron ore during August totaled 3,775,132 tons. The stocks on hand at Lake Erie ports total 32,714,372 tons.

ARKANSAS

Small Manganese and Zinc Mines Again Active

Stimulated by higher prices and greater demand, many minor producers of these metals in the State begin rehabilitating properties

▶The higher prices for zinc and lead that came with the outbreak of the European war have put new life into the north Arkansas zinc and lead field. Small operators have started pick-and-shovel work on lead and zinc deposits and larger operators are rehabilitating mines and mills.

▶J. C. Shepherd, the biggest producer in the field during the last World War period, who has been in Chihuahua, Mexico, since 1919, returned to the north Arkansas field in July, and is operating on a 1,300-acre tract owned by the American Zinc, Lead & Smelting Company. The property is in Newton County, Ark., and the shipping point will be St. Joe, Ark., on the M. and A. Railroad. The mines on this tract are the Bald Hill and Old Confederate. Both properties have been mined during intervals of high ore prices since the Civil War. At present Mr. Shepherd's operations are confined to the Bald Hill. Two shafts are on the property, one 40 ft. deep, the other 70 ft. deep. The 100 ton mill on the property was placed in operation early in October.

▶Though there has been no material advance in the price of manganese ore in the Batesville-Cushman (Arkansas) field, the demand has improved and the production will gradually increase. About sixty small oxide and carbonate deposits are being exploited on leased ground by from two to four men with picks and shovels. No modern mining machinery is being used at this time. Fine ore is cleaned on hand jigs and

Greater demand for iron ore has increased activities in the large Hull-Rust pit of the Oliver Iron Mining Company, Hibbing, Minn.

small log washers, powered with small gasoline engines. Most of the production is oxide ore running from 35 per cent Mn up. It occurs in pockets in clay formation and is easier mined than the carbonate, which is hard ore and lies in well-defined blanket veins. The oxide-ore production is coming from shafts and drifts at various depths from the surface.

Reed Denison, with Walter H. Denison Manganese Company, Cushman, Ark., Inc., which handles most of the ore in the field, states that the field will produce approximately 6,000 tons of high-grade ore this year. This ore runs from 35 per cent. up. If a profitable market could be found for the lower grades, say from 25 per cent up, production could in a few months be stepped up to 100,000 tons a year, including both high and low grades.

▶ The Arkansas Smelting Company will have two furnaces, with two blocks each, in operation at its Van Buren smelter by Oct. 1, according to Roy Madden. About 165 men will be reemployed.

North Carolina

▶ The old Elk Knob copper mine is being reopened in Watauga County by the Carolina Copper Corporation, one of the few mining companies financed largely with North Carolina capital, according to an announcement made recently by State Geologist H. J. Bryson of the Department of Conservation and Development. The vein of copper ore, known as the Elk Knob vein, is located about 15 miles northwest of Boone, in Watauga County, and was actively worked until about 1900. The new corporation, of which John L. Crist, of Charlotte, is president and Leland G. Atkins, also of Charlotte, is secretary, plans to build a mill at the mine just as soon as it has finished some core drilling now in progress.

MICHIGAN

Reclamation Plant at Freda Begins Operations

Copper tailings in Lake Superior being recovered—Famous conglomerate lode is mined out

▶ Copper Range production showed an increase in August, being in excess of 1,500,000 lb. Work has been resumed at the reclamation plant of the company at Freda, where copper from waste sands dumped into Lake Superior is being recovered. The sand is removed by the company's own hydraulic dredge. Copper Range wages recently were increased under the sliding scale based on the price of copper.

▶ The famed conglomerate lode of the Calumet & Hecla Consolidated Copper Company is at an end—mined out. Opened in 1865, the conglomerate, was one of the oldest mines in the United States. The bed was the richest in the

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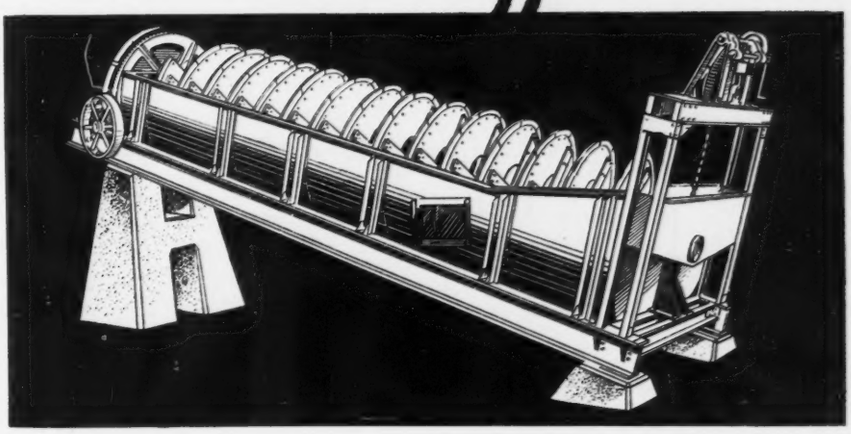

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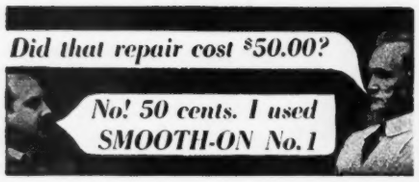

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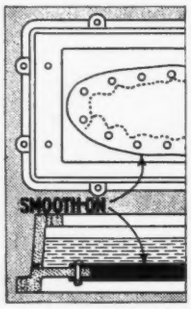

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The Germania mine, of the General Electric Company, in Wellpinit, Wash., is bulldozing tungsten tailings into trucks for re-treatment in its mill

▶MICHIGAN

world in native copper content. Copper occurred as filling matter between the pebbles in irregular branching masses and partly as fine scales impregnating the pebbles and the sand filling between them. The formation was a clearly defined reef, once the bed of a sea. Billions of pounds of copper have been mined from the conglomerate and the company has paid a total of $188,241,333 in dividends to shareholders. Although the company has other mines, the great bulk of the profit came from the rich returns from the conglomerate shafts.

▶ Exhaustion of the conglomerate leaves Calumet & Hecla with one operating mine, Ahmeek. In addition, it is still reclaiming copper from waste conglomerate tailings. It is estimated that it has four more years of operations on the sands at Lake Linden and about two years at the Tamarack plant. Calumet & Hecla has other lodes than the conglomerate, mainly the Kearsarge and Osceola. All of the shafts on these veins, with exception of those of Ahmeek, are idle. A considerably higher price for copper is essential to make operation profitable. Exploratory work in search of new copper deposits is being done in Ontonagon and Keweenaw counties on optioned lands.

▶ Production of the Isle Royale Copper Company in July was 657,000 lb. of copper, the cost of which, sold and delivered, was 9.73c. per pound. August production was 802,000 lb., costing, sold and delivered, 8.92c. per pound. On Sept. 1 no September copper had been sold and Isle Royale was in position to realize the full benefit of a further advance in copper prices.

▶ Mines in upper Michigan have increased their production schedules. The Inland Steel Company has stepped up operations at its Morris mine from a four-day week basis to five days. Five mines of the Cleveland-Cliffs Iron Company increased their operations from three to five days a week.

MEXICO

Mining Industry Prepares for Greater Output

Peso gains strength as the outlook improves for Mexican mines because of the European war—Labor difficulties prevented in some districts

▶ War fulfilled the expectation that it would stimulate Mexican mining. But though exports of mining products, particularly the industrials, shot up since Sept. 3, complaint is heard that the return on these sales abroad is not as great as was anticipated because of the strengthening of the peso against the dollar, a comeback that dropped the value of the American monetary unit in Mexico from the round six to one that obtained from late in June, to about 5.35, and the sharp slump in the value of the pound. Lower rates for dollars and sterling particularly cut the yield from exports of lead and zinc. Mining has, however, picked up considerably. It is estimated that some properties that were shut down because of unprofitable operation will soon resume work. Chihuahua and Durango are expected to benefit especially from this improvement. Keeping mining going smoothly is obviously the desire of the Mexican Government, for the labor authorities have prevented several strikes and other labor difficulties have been patched up.

▶ Full support of workers of American Smelting & Refining Company and Cia. Minera de Peñoles in their demands for new labor contracts has been assured the national miners union by the Alliance of Employees and Workmen of the Mexico Tramways Company, Ltd., a Canadian firm that conducts street-car service in the Federal District.

▶ Cia. Minera de Real del Monte y Pachuca, S.A., has turned its Barron mine, Pachuca, Hidalgo, over to the Dos Carlos mining cooperative to work on a royalty basis for an indefinite period.

▶ Unsettled conditions in Mexican mining due to the war make it impossible now to continue conversations intended to bring about new labor contracts, employees of the Asarco unit at Charcas, San Luis Potosi, were informed by H. Willey, unit manager. This stand is expected to be followed by other mining companies.

▶ President Lazaro Cardenas has ordered troops to protect members of the cooperative society, known as Section 4 of the national miners union, who complained to him that they are victimized by raids of ore thieves at properties they are working near Guanajuato City. This society, which has 1,054 members, threatened a strike that would have affected all mines in Guanajuato had their appeal been denied.

▶ The San Pedro Gilmeonene mine, two miles from Guanajuato City, which was abandoned twenty years ago, is being conditioned for work by the firm of De Votie & Lujan, which owns the Bank of Guanajuato. This operation is employing 300 men.

▶ Four, instead of three, metal-treatment plants for prospectors and other small-scale miners are being established in Sonora by the national commission for stimulation of the mining industry. The plants are to be at Nacozari (100 tons), Altar (50 tons), Alamos (50), and La Colorada (50). The last-named plant is for free-lance miners working tracts that American and British companies abandoned in 1916. The commission is also arranging the establishment of two plants in Guanajuato for small-scale miners, at Mineral de la Luz and Mineral de Cedro. Efforts are being made to have all six plants in operation by the end of fall.

▶ By inducing the workers to accept arbitration of their demands for a new contract that provides various economic benefits, including a general daily salary increase of 60 centavos (some 11c.), the federal labor department announced that it prevented a strike set for Sept. 15 at Asarco's Charcas unit, San Luis Potosi.

▶ Work difficulties involving the Neg. Minera La Consolidada, S.A., and the national miners union were smoothed over when the federal labor department induced both sides to hold conferences with a view to ending their differences, which include demands for higher wages.

▶ President Cardenas has ordered an investigation of complaints of Federal government-sponsored mining cooperative societies in the Palau district, Coahuila, that professional politicians and labor leaders, alleged to be tools of Japanese interests, are obstructing the proper functioning of these organizations. It is charged that very little of the 4,000,000 pesos (about $800,000) the government provided to get these societies going has been employed for that purpose. The complaint says that politicians and labor leaders got most of this money. The complaint declares that the societies would like to know what has become of the proceeds of the sales of 3,500 tons of coke they produced in 60 ovens.

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Specified "SMALL BUT POWERFUL"

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SPECIAL efforts have been made to obtain the maximum drawbar pull from these two new mine locomotives for this operator, one of South America's largest metal producers.

Large-capacity motors are used. The drum-type controller, with line breaker, provides smooth starting and ample protection. The axles are connected by a chain-and-sprocket arrangement. So equipped, slipping of either pair of wheels is prevented and greater drawbar pull is made available.

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Wheelbase—37 in.
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Height—65 in. over cab roof
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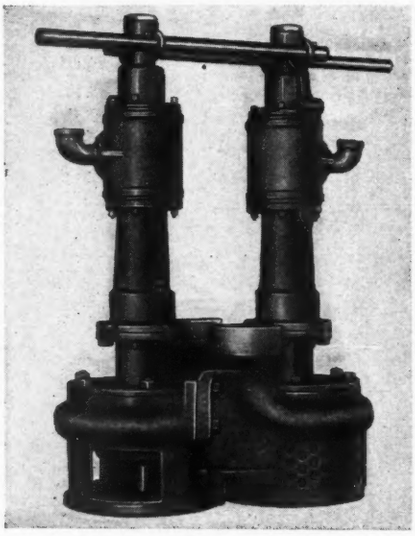

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CANADA

War Virtually Stops All Prospecting

Many crews called in pending clarification of industrial and economic outlook for the Dominion—Large metal producers contract to help supply British Empire

▶ The most immediate effect on mining camps of war declaration at Ottawa was an almost complete stoppage of prospecting and general exploratory work. Consolidated Mining & Smelting alone was responsible for laying off 40 crews; by the middle of September all field parties had been called in by Noranda, Howey, International Mining, and numerous smaller operators. The outlook will continue uncertain until metal markets, financing, labor supply, legislation, and other factors have been stabilized on a war basis. Recruiting by the Royal Air Force threatens a shortage of pilots for air communication with Great Bear Lake and Yellowknife, in the Northwest Territories, as well as with many outlying mining developments in eastern Canada. Commercial air lines will be forced to consolidate, with or without Federal regulation, in order to man essential services that would carry limited freight and passengers to isolated mines. The first war budget adopted by Parliament clearly indicates a government policy that encourages development of new mines. Conditions in general are favorable for increased output by the established producers. Gold mines are permitted to take the benefit of United States exchange in marketing bullion, now holding at around $38 an ounce. Profits above the average for the last four years will be taxed 50 per cent and a new 18 per cent tax on corporate income has been applied; certain benefits to new mines have been continued and reasonable adjustments have been promised in applying the excess-profits tax to new producing mines. Large Canadian producers of base metals have entered into contracts with the British Government to supply copper, lead, and zinc to the British Empire at prices set by the Government.

Ontario

Since the end of June, exploratory work on the 700-ft. level of Kerr-Addison Gold Mines has extended the length of the new east orebody from 510 ft. to 1,300 ft., with the east end still open. Making 3,000 tons per vertical foot, this appears to be one of the largest ore blocks in the mine. Cut grade is officially reported at $6.03 per ton; uncut averages $9.69. The structure appears to be the west continuation of the main "A" ore mass on the adjoining Chesterville property. Shaft sinking to 1,500 ft. should be completed in October, about the time when the new mill is expected to be ready. The 24-hour record of the present milling equipment is 745 tons, with 96 per cent recovery, after a modified flowsheet had improved extraction and increased the capacity by 50 tons. The new mill unit under construction will bring production to more than 1,000 tons daily, and recovery of 98 per cent is promised.

▶ Hasaga Gold Mines, in the Red Lake district, on the west side of the Howey property, is considering a mill increase from the present 170-ton rate to 500 tons or more. Average recovery to the end of June is reported by the president, J. E. Hammell, at $8.23 a ton. Recent development work on the 375 level has opened a new oreshoot. High-grade ore 18 ft. in width is being developed at the same time on the No. 2 property. The No. 1 shaft is being deepened to 1,150 ft. General Engineering Company is preparing plans for the new mill, which is expected to include treatment by cyanidation and flotation.

▶ Dennison Nickel Mines, near Sudbury, plans mill construction as soon as finances can be arranged, according to a report by the president, J. R. Rea. A three-year ore supply for a 200-ton mill is estimated by John C. Rogers, consulting geologist, who averages metallic content of the ore block above the 500-ft. level as containing 1.93 per cent combined copper and nickel and 0.08 oz. platinum. In the last two years $178,377 has been spent, the developments including shaft sinking to 922 ft. and lateral work on six levels.

▶ On Sept. 19 an air blast at the 2,000 level of Lake Shore Mines injured three men. The increasing frequency of air blasts has contributed to the 40c. increase in tonnage operating costs shown in the recently issued annual report. In the opinion of Dr. W. P. St. Charles, president, no increase in net earnings is expected for the fiscal year ending next June. Early in 1939, with the completion of a roasting plant, gold extraction improved from 96 to 97.5 per cent. The mill treated 898,894 tons in the last fiscal year, about 31,000 under the previous twelve months, with an average grade of $16.25, compared with $16.19 the year before. Almost 400,000 tons of waste rock and sand backfill were placed in the stopes during the period. Permanent wall support is placed at the time when ore is removed, leaving no open ground in the mine. The No. 4 internal development shaft has been deepened to 4,700 ft., and later this year it is planned to open two new levels. On the bottom 4,450-ft. level the partial development of the north vein has been giving good results, as has exploration on subsidiary and branching fractures. E. W. Todd is mine superintendent.

▶ Macassa Mines, Kirkland Lake, made a new tonnage record in August, when 12,578 tons were treated. The grade averaged $15.12 a ton, compared with $15.51 for the first eight months of the year, from a total of 98,567 tons. In the same period a year ago mill feed amounted to 64,507 tons.

Quebec

▶ Aldermac Copper Corporation, located seven miles west of Noranda, has negotiated contracts with firms in New Jersey and the middle West for approxi-

mately 80,000 tons of pyrite. Shipments from the large stockpile at the mine are now going forward at the rate of 750 tons a day, replacing pyrite formerly supplied by Rio Tinto. In the past year pyrite shipments from Aldermac have not exceeded 6,576 tons. In that period there was a net loss of $81,012 from the treatment of 358,902 tons having a copper content of 1.91 per cent. A. V. Corlett is mine manager.

▶ Noranda Mines will also begin shipments of pyrite to an American firm as soon as a dryer and car-loading equipment can be installed. The new contract calls for 100 tons daily. A by-product of the Noranda cyanide plant, pyrite has in the past been allowed to go in tailings. There is no intention at present to recover sulphur dioxide from smelter fumes for production of sulphuric acid, which is being manufactured at Sudbury and Trail.

▶ The No. 3 shaft at O'Brien Gold Mines, Cadillac Township, has been deepened from 607 ft. to 1,480 ft. in the fast time of 139 working days. A crosscut has been driven to the No. 2 shaft workings on the 13th level. New deep levels will be developed after a program of diamond drilling has tested the downward extension of the high-grade found on the first four levels. Harry Sparks is mine manager.

▶ Perron Gold Mines, in the Pascalis area adjoining the Courner, shows continued improvement in earnings. August production averaged $12.35 per ton from 11,804 tons, and for the first eight months $921,288 from ore averaging $10.58 a ton. This compares with $828,333 for the same period of 1938, when recovery was $10.13. The major ore developments on vein No. 32 have now been carried out on five successive levels, surpassing in both grade and tonnage any oreshoots now known. On the 925 level the vein has disclosed 600 ft. of ore averaging $12.25 a ton, cut, and widths in places exceeding 8 ft. The vein is believed to apex just above the 625 level, where the ore length is limited to 100 ft. The 1,025 level is undergoing development to check a 425-ft. length on the vein indicated by diamond-drill holes. Ore discoveries recently made in several sections of the mine will not be explored until more systematic work has been done on vein No. 32. J. P. Norrie, general manager, reports that no mining has yet been done below the 625 level.

British Columbia

▶ The outbreak of war finds the mining industry of British Columbia prepared to render to the Allies much greater service than in 1914. Gold output has been doubled, the total production last year amounting to $20,000,000. Copper production is approximately 50 per cent greater than in 1914 and last year amounted to over 65,000,000 lb. The greatest advance, however, has been in production of lead and zinc by the Consolidated Mining & Smelting Company. In 1914 the output of the Province was a little over 50,000,000 lb. of lead and 7,750,000 lb. of zinc, whereas today the capacity of the Trail plant is over 400,000,000 lb. of lead and approximately

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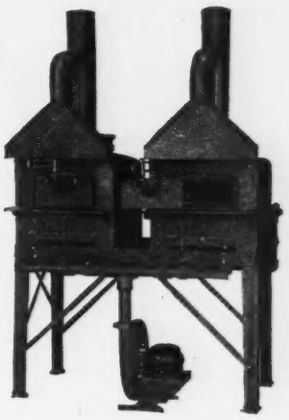

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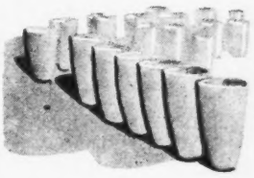

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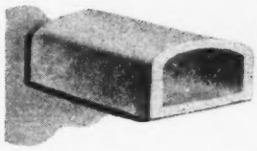
As few as 6 or as many as 90 twenty gram crucibles per furnace of one, two, or three muffles.



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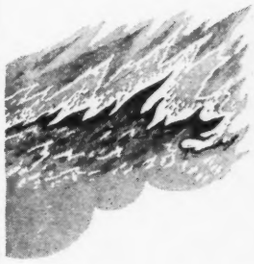

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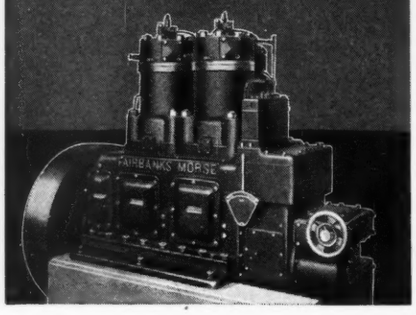

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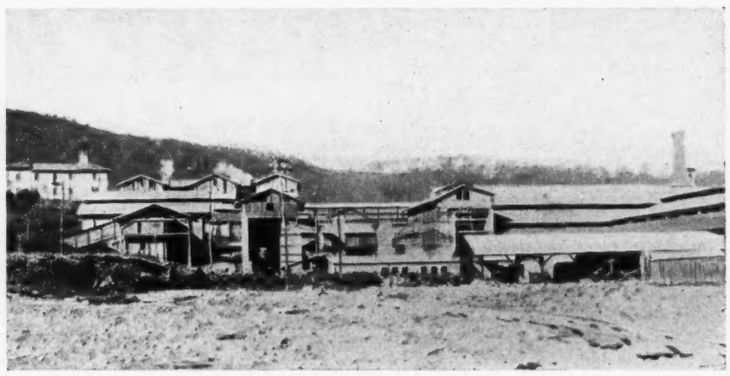

At Monte Amiata, Italy, this reduction plant recovers much of the mercurial salts produced in that country. Mercury production in Italy is gradually increasing

▶CANADA

3,000,000 lb. of zinc. It is anticipated that the war demand will create new all-time records in the production of these metals and that there will be substantial improvements in the outputs of the subsidiary products such as silver, bismuth, cadmium, antimony, and other materials of this nature. A number of lead and zinc mines which have been closed for several years, owing to the low prices of these metals, but which are equipped with mills and can commence operating at short notice, will be able to go into production should circumstances justify their doing so. Examples of these are the Monarch, at Field; the Reeves MacDonald and the Lucky Jim mines; and the Whitewater mine.

▶ Mount Zeballos Gold Mining Company, financed and controlled by the Conwest Exploration Company, of Toronto, of which Fred M. Connell is president, has installed a 35-ton mill on its property, which commenced operating on Aug. 11.

▶ At the Privateer, development on the No. 2 vein is giving satisfactory results. This has been drifted for a length of over 200 ft. and has disclosed values which average over 0.5 oz. on a stoping width of 3 ft.

▶ A new company, the Musketeer Mines, has been formed and is owned jointly by Pioneer Gold Mines and Anglo Huronian, Ltd. A. E. Bull, president of the new company, states that it is planned to instal development machinery to enable a deep-level crosscut tunnel to be driven which will cut the main vein and open up three other veins believed to be of commercial value. The directors hope that the property will develop a small milling operation before long.

▶ Gem Gold Mines, Ltd., situated on Texada Island, 72 miles north of Vancouver, has built a 60-ton mill on its property. This operation is financed by New York interests. Ralph A. Logan is manager. Thirty-two veins have so far been disclosed by development, four of which have already been explored with satisfactory results, and exploration is proceeding on many of the others. The property is equipped with a 150-hp. Fairbanks-Morse diesel engine, driving two generators and three compressors.

▶ The first ton of tungsten concentrate from the Columbia Tungsten company's property on Hardscrabble Creek, near Wells, in the Cariboo district, has been shipped to the East for final reduction. A 50-ton pilot mill was recently installed at this mine, replacing an earlier plant previously destroyed by fire. The present plant will be used experimentally in part, to determine what kind of treatment is best suited for the scheelite deposit being worked by the company. The concentrate goes to Atlas Steels, Ltd., at Welland, Ontario. Fred L. Hewitt, president, of New York, paid a visit to the mine recently.

Silesia

▶ At the outbreak of the Polish-German war all properties of vital industries in Polish Silesia were placed under military control by Poland. Silesian-American Corporation, including its subsidiary Giesche Spolka Akcyjna, a large zinc producer, lying in a mineralized area extending about 50 miles east from the Oder River in Germany to Olkusz in Poland, was, however, taken over by the German Government in its advance through Poland. The German Government appointed a Commissar to take over the properties.

Yugoslavia

▶ Trepca Mines closed down its Stantrg mine the middle of August and dismissed the 2,224 workmen who were on strike. A fortnight later the company began recruiting labor with a view to reopening the mine. It is reported that workers living in lodgings will receive 4 dinars per day, and those having ten years' service will be given a week's paid vacation. In other respects conditions existing before the strike will be maintained. Yugoslavia is seeking to maintain strict neutrality.

AFRICA

Gold Output Expected To Remain Normal

South African producers will turn over to government all profits above the price of 150s. per ounce for gold—Large mineral survey of Kenya Colony under way

▶ The South African Government "proposes to appropriate all gold mining profits above a price of 150s. per ounce," is the way a statement coming from there is worded. It is taken to mean that whatever the companies receive in excess of 150s. per ounce they must surrender to the government, and though that is not what the statement says, it is probably what it means. At the time of its issue gold was 168s. in London. If this decree is put into effect it will apply only to the Witwatersrand and other producing mines in the Union of South Africa, and will not restrict the profits of Gold Coast, Southern Rhodesia, and East African producers. Though it sets up a dangerous precedent, it won't be likely to restrict activities in South Africa.

▶ Western Holdings has now made a strike in the Orange Free State, 150 miles southwest of Johannesburg, which seems to establish that district. "Toronto No. 1 borehole" passed through 3 ft. of reef at a depth of 1,251 ft. which assays 10.5 dwt. per ton. It is stated, though unofficially, that this hole is 8,000 ft. north of the very rich St. Helena No. 7, and 6,200 ft. from Vlakplaats No. 4. These and other boreholes are said to indicate the possibility of a continuously mineralized reef over a length of 3¾ miles.

▶ An extensive mineral survey of Kenya Colony, East Africa, is to begin almost immediately. The Colonial Development Fund has made a grant of £30,000 to defray the expense. In some quarters the opinion is held that Kenya possesses great mineral resources, sodium, salt, tin, mica, and diamonds, as well as gold, having been found there, and mercury, copper, lead, manganese, corundum and other minerals are reported to occur. Seven areas, comprising 15,000 square miles, have been selected for exploration.

▶ Otavia Mines and Railway has declared a final dividend for the year to April 30 last. This company was registered in South-West Africa in 1901 and re-registered in Berlin in 1921. It owns mining rights over 1,000 square miles in South-West Africa which includes producing copper, lead, and silver mines. The dividend, Rm. 0.45, is equivalent to 7½ per cent, and makes 15 per cent for the year, and arrangements had been made to pay British holders before the outbreak of war. Net earnings last year, sufficient to pay the dividends, are understood to compare with a loss the preceding year.

▶ Nchanga Consolidated's report shows cash on hand, March 31, £1,732,415. To-

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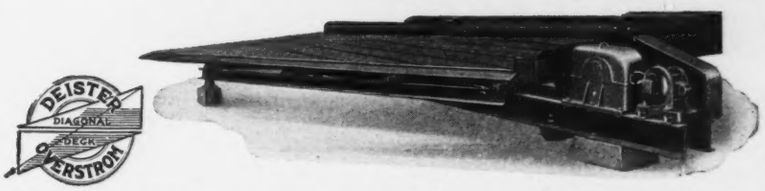

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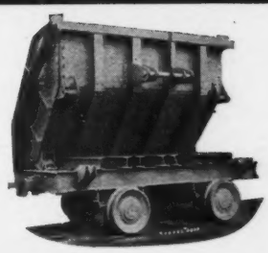

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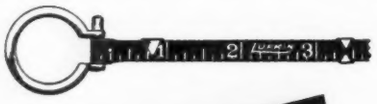

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▶AFRICA

tal underground development during the year came to 6,153 ft. Beds overlying the ore were gradually dewatered, and diamond drilling was started to expedite this. Results so far indicate that while mining the portion of ore above 470-ft. level it will be necessary to pump only 6,000,000 to 7,000,000 gal. daily. At the date of the report an engineer was studying the deposit to determine the best mining method, and the pilot plant was 60 per cent completed. The pilot plant will have a capacity of 500 tons daily, being so designed that equipment can be incorporated in the permanent plant.

▶ Indicative of the relative rapidity with which mines may be and are being developed in the deep deposits of the Far Western Witwatersrand is a statement by Venterspost Gold Mining Company that it already has fully developed ore reserves of 2,044,000 tons averaging 4.8 dwt. per ton over an average stoping width of 90.8 in. Venterspost was incorporated five years ago. It has sunk two deep shafts, which are now connected, and the first section of the 100,000-tons per month treatment plant it has been building is now ready to go into operation. This company is a subsidiary of West Witwatersrand Areas, Ltd.

▶ The work of developing and equipping several of the Gold Coast mines for greatly increased production is going ahead rapidly. Ariston Gold Mines, for instance, is now hoisting through its new central shaft. Expansion of output is well under way, 40,200 tons being crushed in the June quarter, against 36,330 tons in the March quarter, and this will be increased almost immediately to 60,000 tons per quarter. This mine is opening up satisfactorily, a crosscut on the 24th level, the deepest point in the Prestea section, having revealed 27.01 dwt. per ton over a width of 60 in. A recent development in the main reef section is 7.47 dwt. over a width of about 54 ft.

▶ Surface prospecting by Marlu Gold on the Broomassie, and the Bu-Esichem and Quaw Badoo concessions, is reported as having proved encouraging. Marlu is interested in oxidized ores. It is mining a large deposit by surface excavation, and reports having exposed other deposits within easy transport distance of its plant, the size of which is in consequence being increased. Operating costs during the June quarter averaged 7s. 3¾d. per ton, which is the price of 1 dwt. of gold. The June quarter mine profit was £151,264.

▶ The problem of obtaining sufficient native labor to work the gold mines on South Africa's famous Witwatersrand is becoming acute, according to a report from the American consulate-general, Johannesburg, made public by the United States Department of Commerce. Natives of the Union are increasingly reluctant to undertake work in the mines, and the British territories to the north are unwilling to permit any large numbers of their natives to emigrate.

AUSTRALIA

Lake View & Star, Ltd., To Build Large Mill

Plant will treat Chaffers dump ore—Flotation mill of The Zinc Corporation begins operations—Tin prospect found in North Queensland

▶ Official statistics record gold production for the first six months of 1939 at 768,691 oz., compared with 746,318 oz. during the corresponding period of last year. Output of about 1,650,000 oz. will be all that will be attained this year, observers believe.

Western Australia

▶ Lake View & Star, Ltd., at Kalgoorlie, plans to erect a new tailings re-treatment plant to treat the old Chaffers dump at the south end of the Golden Mile. Capacity will be 60,000 short tons monthly, at which rate the Chaffers dump is expected to last four or five years. To provide power for the extended re-treatment operations, a new diesel set of 1100 hp. will be installed.

▶ Sinking of the main shaft of Sons of Gwalia, Ltd., Leonora, has been completed at No. 30 level, which is being opened out at an inclined depth of 5,025 ft. Further opening up of the mine at depth will be done from a new internal shaft, which will be situated in the footwall of the orebody. Mechanical transport connecting the two shafts will be provided at the No. 30 level.

▶ Activity in the Mount Monger district is continuing, with the formation of Haoma Gold Syndicate, N. L., to take an option over the Haoma lease, adjoining the Milano property, which continues to open up rich ore. The Haoma property is of similar type, having a rich narrow quartz leader in kaolin.

▶ Although Central Norseman Gold Corporation, N. L., at Norseman, sustained a loss of £11,981 Australian for the year ended March 31, prospects have greatly improved in recent months. Extension of mill capacity, at present about 8,000 long tons monthly, is expected when ore from the southern part of the vein, which comes into the company's leases at a vertical depth of 1,350 ft., is opened up.

▶ The adjoining Norseman Gold Mines, N. L., is increasing its capital to permit of extensions to mill capacity which will lift the tonnage treated from 15,000 to 18,000 short tons per month.

New South Wales

▶ The new all-flotation mill of The Zinc Corporation, Ltd., Broken Hill, went into operation on Aug. 11, the new Freeman shaft and accessory underground equipment going into use at about the same time. The mill design is notable for its extreme simplicity, and its operations will be watched with keen interest among local mining men. Broken Hill South, Ltd., is the first of the Broken Hill companies to

announce its results for 1938-39. Net profit for the year ended June 30 was £350,007 Australian, a drop of £52.494 from the previous year's record. This decrease was due to lower metal prices.

▶ New Occidental Gold Mines, N. L., at Cobar, reports having cut the south end of the New Occidental lode in a drill hole put out from No. 11 level. The lode was cut at a depth of 450 ft. below No. 10 level and was 15 ft. true width, assaying 9.5 dwt., which figures, it is stated, are comparable with those of the upper levels at this position.

Queensland

▶ Prospects of developing a goldfield of some size at Lolworth are considered good. The largest body is on the Mons Meg property, the last crushing from which averaged 7 dwt. The Midas is a pipe formation of heavily mineralized ore which is treated at Chillagoe Smelters. A recent parcel of 25 tons "prill ore" assayed 7 oz. per ton.

▶ Tin mining is very active in North Queensland, and a new prospect recently discovered at Mount Helen has created much interest.

Victoria

▶ North Deborah Mining Company, N. L., at Bendigo, has had a good development in rising from the 480-ft. level, stone 3 ft. wide showing visible gold having been struck. The reef is one that has not been previously developed in this mine. The company recently joined the list of dividend payers, some two years after its formation.

▶ Wattle Gully Gold Mines, at Chewton, which had a net profit of £18,157 for the half-year to June 30, derived from the treatment of 10,099 tons of ore, expects that in future 2½ dwt. will be sufficient to meet its costs. The decrease in cost will arise from the 50% increase in battery capacity, recently installed.

▶ Morning Star (GMA) Gold Mines, N. L., Woods Point, whose plant has been out of operation since January, when it was destroyed by bushfire, has resumed production.

▶ Adelong Gold Estates, N. L., a dredging concern operating in the Ovens River Valley, has resumed work after a shutdown since last April. During the period a complete reconditioning of the plant was carried out.

Tasmania

▶ Due to incessant rain, Briseis Consolidated, operating the Briseis tin-sluicing mine at Derby, experienced several falls of drift and overburden during August, which prevented access to the richer bottom gravels and seriously interfered with production. Removal of the fallen material from the bottom occupied most of September.

▶ Montana Silver Lead, N. L., which has been developing a property near Zeehan since 1937, has decided to erect a small treatment plant. Capacity will be 50 tons daily, and it is expected that the mill will be in operation in about seven months.

HENDY

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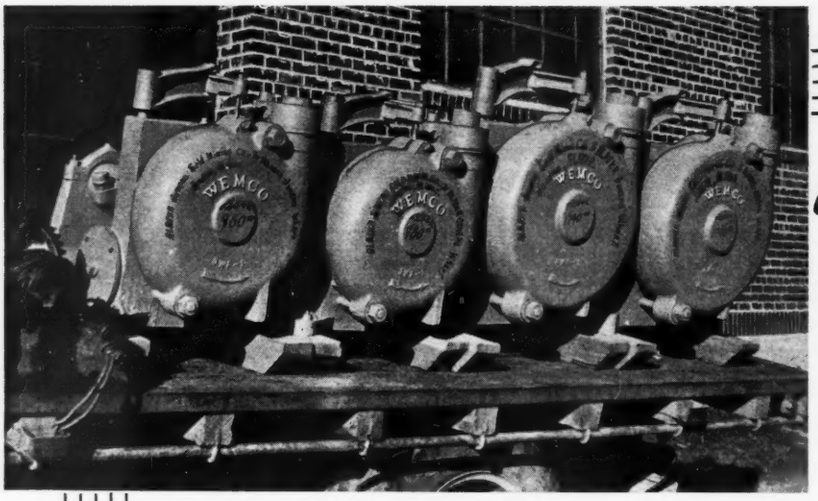

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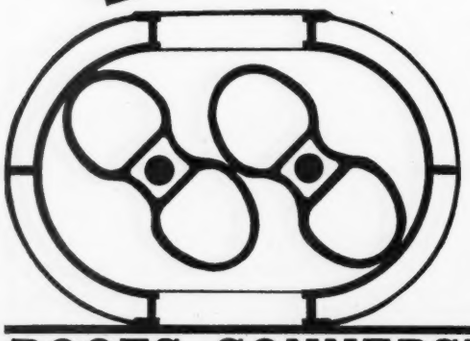

On concentrators, smelters, converters, and acid plant applications, the reason behind the purchase of each piece of Roots-Connersville equipment is easy to find. Decreased operating cost because of lower power consumption, lower depreciation, small maintenance, and elimination of losses from service interruptions is the answer. May we send you complete information?

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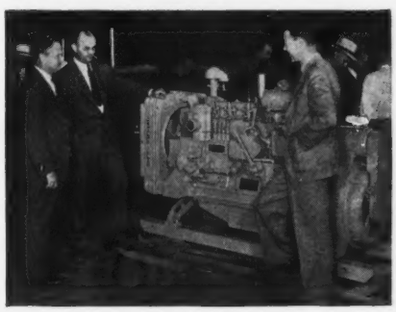
EQUIPMENT NEWS

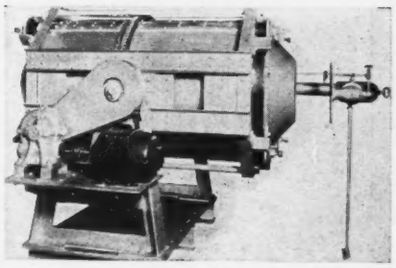
A Hotmill for Detachable Bits

A PRODUCTION MACHINE, known as the Jackmill, has been developed by Ingersoll-Rand Company, Phillipsburgh, N. J., for reconditioning the company's detachable rock-drill bit, the Jackbit. This hot-milling machine is built in two

sizes: the JMA, shown herewith, which redresses 110 to 180 Jackbits per hour; and the JMB, which redresses 75 to 90 Jackbits per hour. Both machines are equipped with electric motor drive. The feed mechanism of the JMA is air-operated. Each of these Jackmills has a single cutter which does both gaging and sharpening. The cutter of the larger mill will redress 40,000 to 60,000 bits, and the cutter of the small mill is said to handle 15,000 to 30,000 bits, before it needs resharpening. These cutters can be reconditioned a number of times, so that the cutter cost per Jackbit sharpened is said to run less than one-tenth of a cent.



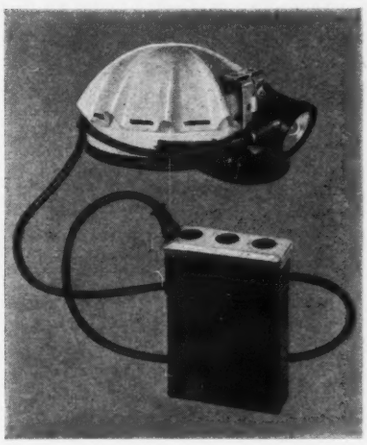
Executives of the Caterpiller Tractor Company, Peoria, Ill., look over the new compact Diesel Electric set that requires connection of only two wires to start the unit



Monarch Engineering Company, Baltimore, Md., announces a new tilting and revolving furnace for smelting ores and concentrates. Capacities range from 500 lb. to 5 tons and the furnaces are equipped for oil or gas burning

New Electric Cap Lamp

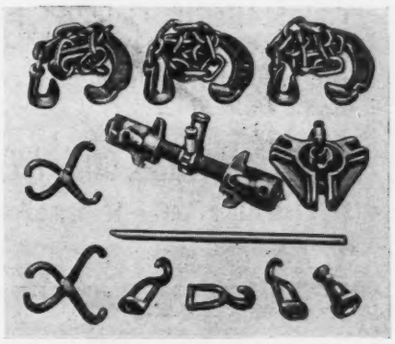
THE Portable Lamp & Equipment Company, 78 First Ave., Pittsburgh, Pa., recently introduced a new permissible electric cap lamp which bears Bureau of Mines Approval No. 27. The headpiece



of the new lamp, made of hard rubber, light in weight but rugged, is said to embody a hinged cap hook permitting the wearer to adjust direction of the beam and focus the light according to his individual needs. A double filament lamp eliminates all danger of light failure from that source. Connection between the light-weight, moulded-rubber headpiece and the battery cord is made by means of a combination switch and charging plug which controls all functions of the lamp, including burning of either filament and charging of battery. The entire switch assembly is said to be made of phosphor-bronze, for high conductivity with a minimum of corrosion, and is permanently sealed against unauthorized disassociation. A three-cell, six-volt lead acid battery is connected to the headpiece by a rubber-sheathed cable especially made to withstand extreme flexing. Gravity type valves are used with non-spilling vents, which prevent leakage and spillage.

Carbon Monoxide Indicator

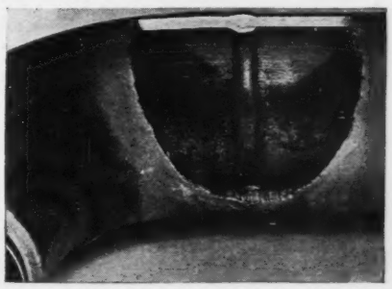
THE Mine Safety Appliances Company, Braddock, Thomas and Meade Streets, Pittsburgh, Pa.; announces a new portable M. S. A. hand-operated carbon-monoxide indicator. This instrument is said to possess a wider range of utility in the field than any other heretofore available, and is small, highly efficient, and provides great simplicity of operation in testing atmospheres for the presence of carbon monoxide. The instrument is sensitive to concentrations of carbon monoxide as low as a few thousandths of a percent, and is accurate, light, and easy to carry. No wires or other connections are required. The indicator can be used anywhere.



Templeton, Kenly & Company, Chicago, Ill., offers this 10-ton capacity "Util-A-Tool" for pushing, hoisting, lifting, bracing, or clamping structural members of movable objects

Welding Pipe

A NEW TYPE of seamless forged-steel welding fitting has been announced by Taylor Forge & Pipe Works, P. O. Box 485, Chicago, Ill., to supplement the present line of Taylor Forge WeldELLS. The outstanding feature of this welding fitting is said to be the annular lip, which is forged integral with the fitting, as illustrated. By firmly centering the fitting in the pipe to which it is to be welded, the lip eliminates the need for backing rings, clamps, and guides for holding the fitting in position, and is said to simplify and expedite pipe welding greatly. Particular emphasis is placed by the manufacturer on the fact



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Latest Improvements In

PLAT-O ORE CONCENTRATING TABLES for concentrating any ore from ¼" to slimes. *Bulletin No. 20B.*

PLAT-O HEAVY DUTY VIBRATING SCREENS for large tonnages ore, sand and gravel, crushed stone, etc. *Bulletin No. 26.*

MULTIRAP VIBRATOR—High speed for fine screening. Non-blinding, high efficiency, long life screen cloth. *Bulletin No. 24.*

COMPOUND FUNNEL CLASSIFIER—Gold trap for coarse gold. Preparation of ore pulps for table concentration. *Bulletin 23.*

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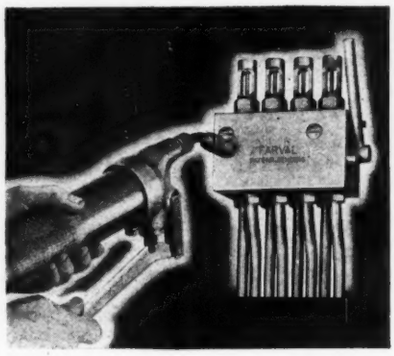
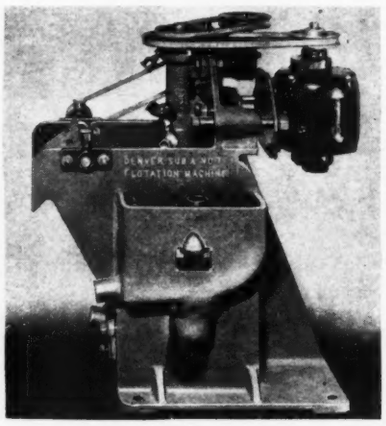
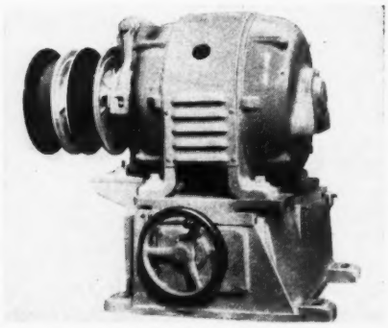
that the ring remains cooler during the welding than the molten weld metal. As a result, the bottom of the "V" appears darker than the sides. This color contrast is said to be an ideal guide to the welder, permitting him to obtain complete penetration without burning through. Attention is also called to the smooth contour formed by the streamlined lip, which minimizes flow resistance.



The Farvel Corporation, Cleveland, Ohio, announces the DX Multiple measuring value that delivers lubricants to bearings through one set of valve outlets



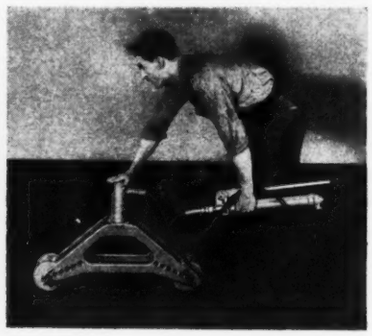
Denver Equipment Company, Denver, Colo., announces it has redesigned its line of continuous laboratory machines



A multiple belt for variablespeed-drive motors is announced by the United States Electrical Motors, Inc., 200 East Slauson Ave., Los Angeles, Calif. Speed changes are effected by turning the hand wheel

Pipe Bender

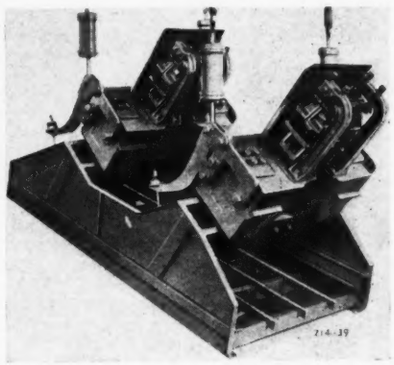
THE BLACKHAWK Manufacturing Company, Milwaukee, Wis., announces its new "Porto-Power" pipe bender for use in bending seven sizes of rigid conduit and pipe, including 1¼, 1½, 2½, 3, 3½, and 4 in. diameters. A 20 ton capacity hydraulic unit is employed in the bending process and is part of the



complete apparatus used in bending the pipe. Weighing 190 lb., the unit is said to have a simplified one-piece bending ram which eliminates thirteen various extension bars, tension arms, studs, etc. The manufacturer claims time-saving advantages for the new "pull-pin" method of fastening the rotating pivot shoes, a principle that is said to make wrenches unnecessary in assembly. These units are packed in portable kits for carrying directly to the pipe-bending job.

Piano Wire Screen

A NEW TYPE of screen cloth was recently introduced by the Jeffrey Manufacturing Company, Columbus, Ohio. The design of the screen involves the use of piano wires that are run in one direction only, with no cross wires. The screen cloth is said to be stretched to such a high tension that the individual

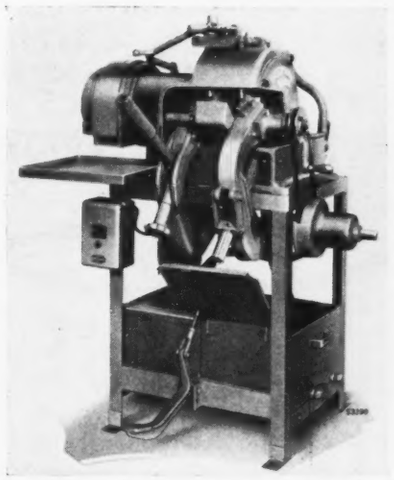


wires develop a resonance having the peculiar property of passing undersize particles more rapidly than the conventional types of cloth. The manufacturer claims this piano wire has greater capacity and longer life, with almost complete freedom from blinding. Due to the tension placed in the wires, the screen sash holding them is especially constructed. This cloth is made in meshes from ⅜ in. to 120 mesh and can be furnished in stainless steel. The Jeffrey-Traylor electric vibrating Conveyanscreen shown above is equipped with this new screen.

Face Shields

THE BOYER-CAMPBELL Company, Detroit, Mich., announces a face shield that can be converted into three types. It has been made practical with complete interchangeability of parts, and the screen guard may be buttoned on at the option of the wearer. When fitted with the Plastacele window it is used when spot, flash, and gun welding, buffing, polishing, or wire brushing. When using

the wire screen window it is said to be a protection against heat and babbitting. The fiber front and glass holder give the wearer protection for acetylene welding, burning, scarfing, etc.



Ingersoll-Rand Company, Phillipsburg, N. J., announces a new non-automatic Jackbit grinder, J-3, for use with all types of standard detachable bits

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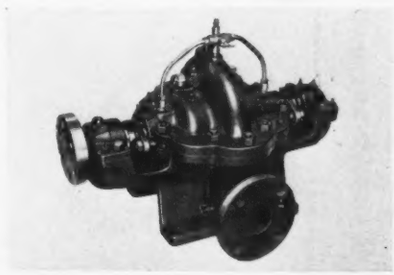

Centrifugal Pump Division of the Allis-Chalmers Mfg. Company, Milwaukee, Wis., announces the inclusion of ball bearings as standard equipment on nearly all its lines of single-stage, centrifugal pumps where peripheral speeds are not excessive and where quality of the pumps are not jeopardized thereby.

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. . . Two unique factors that "add up" to BETTER, LOWER-COST MATERIALS HANDLING with

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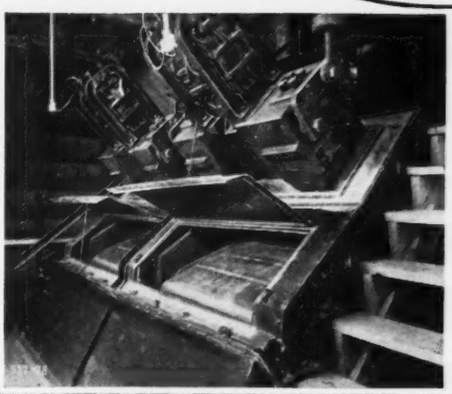
This all-electric principle increases efficiency and "thru-screen" capacities on intermediate and fine materials



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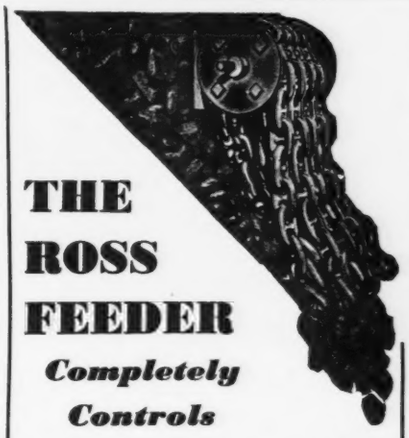

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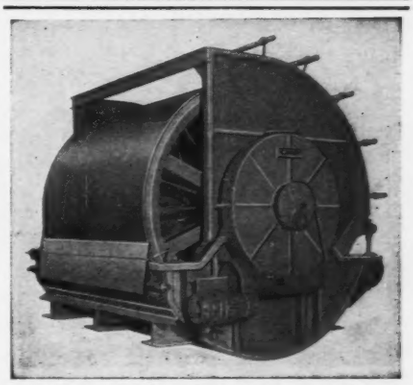

CONTINUOUS - VACUUM

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• Illustration above shows Eimco Drum Filter recently furnished to large Canadian gold mining company for washing and dewatering cyanide slimes. Many other installations throughout the entire mining world are giving *better results, at very much less expense for operation and maintenance* than has ever before been possible.

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INDUSTRIAL NOTES

Iron & Steel Products, Inc., Chicago, Ill., announce the appointment of Senor Pedro C. Morales as their Mexico representative with office at Chopo 24, Mexico, D. F.

Earl W. Berry has been appointed distributor of mining and milling equipment manufactured by the Western Machinery Company, for the Philippine Islands. Mr. Berry's address is P. O. Box 1177, Manila, Philippine Islands.

G. W. Bennett, mining engineer, for the past sixteen years with Symons Bros. Company, recently joined the Birdsboro-Buchanan Crusher Division of the Birdsboro Steel Foundry & Machine Company.

Morris Machine Works, of Baldwinsville, N. Y., announces the reappointment of Pierce J. McAuliffe as New York representative, with office at 254 West 31st St., New York, N. Y. Mr. McAuliffe originally joined the company in 1910 as designer of hydraulic dredging equipment.

Bertrand Robinson has been placed in charge of the new Canadian office of Hardinge & Company, Inc., of Toronto.

Food Machinery Corporation, Los Angeles, recently announced the purchase of the Kimball-Krogh Pump Company, a division of the Victor Equipment Company. The Food Machinery Corporation is a large manufacturer of deep-well pumping equipment through its Peerless Pump Division, and Kimball-Krogh will now be merged into another pump manufacturing unit of the Food Machinery Corporation.

The Linde Air Products Company, the Oxweld Railway Service Company; Carbide & Carbon Chemicals Corporation; Union Carbide Company; Electro Metallurgical Company; and Haynes Stellite Company, all units of the Union Carbide & Carbon Corporation, announce their change of address from 205 East 42d St., to Carbide & Carbon Building, 30 East 42d St., New York, N. Y.

R. W. Eichenberger, vice president of the Robins Conveying Belt Company, has been transferred to the New York Office at 15 Park Row.

BULLETINS

Leather Belting. E. F. Houghton & Co., 240 West Somerset St., Philadelphia, Pa. The research staff of the manufacturer reports on the science of impregnating leather, and the illustrated brochure is entitled "Research Illustrated." Pp. 20.

Manganese Steel. The American Manganese Steel Division, Chicago Heights, Ill. Catalog 59 illustrates manganese steel castings for equipment from many industries exposed to impact and abrasion. Pp. 64.

Screens. Robins Conveying Belt Co., 15 Park Row, New York, N. Y. Bulletin 105 illustrates and describes features of the manufacturer's Style H and Style J. Vibrex screens. Pp. 9. Bulletin 106 illustrates and describes equipment for car and barge haulage systems, and car retarders. Pp. 12.

Diamond Drills. E. J. Longyear Co., Minneapolis, Minn. Bulletin 56 describes the Longyear Junior Straitline diamond-core drill, powered by air, gasoline, or electric motor. Pp. 4.

Fine-Grinding Mill. Stephens-Adamson Mfg. Co., Aurora, Ill. Catalog 639 describes and illustrates features of the Moseley mill, said to pulverize dry materials to any desired size from 10 to 325 mesh. Pp. 12.

Pillow Blocks. Catalog 739 describes the manufacturer's Seal Master ball-bearing pillow block. Pp. 4.

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Crushers. Smith Engineering Works, Milwaukee, Wis. Bulletin 263E describes and illustrates the company's Gyrasphere for use in secondary crushing practice. Specification tables are included. Pp. 15.

Jar Mills. The U. S. Stoneware Co., 60 East 42d St., New York, N. Y. Bulletin 250 describes and illustrates various sized roller-type jar mills for pulverizing in commercial and laboratory use. Pp. 4.

Equipment for Electric Mine Haulage. 22 is a stiff-cover book, handsomely illustrated, that contains a full description of Ohio Brass Co., Mansfield, Ohio. Catalog the manufacturer's products for use in electric mine haulage. Some of the products covered are insulators, feeder and trolley materials, catenary materials, control devices, locomotive headlights, rail bonds, third-rail insulators, and automatic couplers. Useful tables are included. Pp. 160.

Jaw Crusher. Hassell Engineering Co., Colorado Springs, Colo. Bulletin CR-139 describes and illustrates four sizes of jaw crusher, largest being 9x16 in. **Cone-Head Ball Mills.** Bulletin B-139 specifies dimensions of the manufacturer's various sizes of cone-head ball mills.

Filters. Morse Bros. Machinery Co., P. O. Box 1708, Denver, Colo. Bulletin 910 describes and illustrates the manufacturer's drum and disk type of continuous vacuum filters. Pp. 8.

Ultra-violet Sun Lamps. Hanovia Chemical & Mfg. Co., Newark, N. J. Folder illustrates installation of sun lamps for group irradiation at mines, schools and hospitals. Pp. 6.

Power Transmission. Morse Chain Co., Ithaca, N. Y. Bulletin 75 contains illustration design data, capacity curves, and sprocket information and describes features of self-lubricating links. Pp. 12.

Portable Compressor. Chicago Pneumatic Tool Co., 6 East 44th St., New York, N. Y. Bulletin 762 describes and illustrates the manufacturer's 700-cu. ft. portable diesel-driven compressor. Pp. 7.

Drifters. Worthington Pump & Machinery Co., Harrison, N. J. Bulletin H-1200-B-25 describes and illustrates three heavy-duty drifters of screw feed, air motor feed, and pneumatic feed types by the manufacturers. Pp. 6.

Metal-Inclosed Switchgear. General Electric Co., Schenectady, N. Y. GEA-2596A describes and illustrates metal-inclosed switchgear; pp. 16. **Low-Speed Synchronous Motors.** GEA-137-D folder illustrates Type TS low-speed synchronous motors; pp. 4. **Low-Speed Synchronous Generators.** GEA-1960A. illustrates Type AT Band ATI; pp. 4. **Magnetic Starter.** GEA-2964A describes and profusely illustrates features of the new D-51 starter; pp. 6. **Oil Blast Circuit Breakers.** GEA-2426B describes the type Flo oil blast circuit breakers with silver to silver contacts; pp. 8. **Industrial Locomotives.** GEA-3071A Bulletin contains blueprint specifications of 23-, 35-, and 43-ton capacity diesel-electric industrial locomotives; pp. 7.

Wire and Filler Cloth. Metal Wire Cloth Co., Inc., Bronx Borough, New York, N. Y. The loose-leaf bulletin is a comprehensive treatise on the use of wire and filter cloths, containing much data on filter cloths and various types of wire cloth. One page is devoted to flow rates, and an index of permeability is given. Pp. 47.

Printing Foil. Ozalid Corporation, 354 Fourth Ave., New York, N. Y. Form OZ 171 describes and illustrates a new light-sensitive transparent foil for reproducing tracings. Pp. 4.

Maintenance of Metal Surfaces. New Jersey Zinc Co., 160 Front St., New York, N. Y. The illustrated booklet describes the uses of zinc-dust paints and is a complete treatise of this type of rust-inhibitive paint. Pp. 36.

Agitating and Mixing Equipment. Patterson Foundry & Machine Co., East Liverpool, Ohio. Catalog 395 is a complete illustrated book of the manufacturer's agitators and mixers for the process industries. Pp. 95.

Stainless Electrodes. The McKay Co., Pittsburgh, Pa. Small booklet describes features of welding electrodes for stainless steels. Pp. 16.

Pumps. Pomona Pump Co., 206 East Commercial St., Pomona, Calif. "Pump Handbook" is an attractively printed, loose-bound, 138-page reference book on the company's complete line of deep-well and low-lift pumps, showing practical pump applications for almost every class of pumping problem and discussing the engineering principles underlying the design and operation of these pumps. It presents a summation of findings, developments, and

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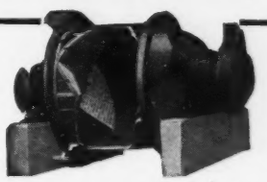

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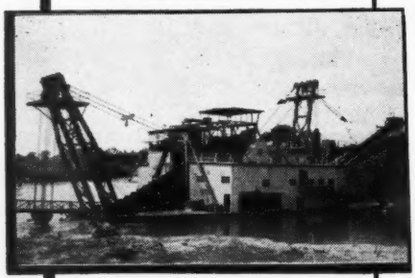

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available data pertinent to the use of turbine-type pumps. A complete hydraulic engineering section of charts, tables, formulas, and other useful pumping data is included in the text.

Blasting. Atlas Powder Co., Wilmington, Del. Leaflet entitled "Ways and Means to Greater Safety" contains suggestions on priming wire connections and blasting-machine operation. Pp. 6.

Threading Tools. Oster Manufacturing Co., Cleveland, Ohio. Catalog 39A describes and illustrates the manufacturer's threading tools and new machines. Time studies, threading speeds, and other data are also given. Pp. 32.

Storage Batteries. Electric Storage Battery Co., Allegheny Ave. and 19th St., Philadelphia, Pa. Section MP-1 gives illustrations and complete data on operating characteristics, capacities, sizes, and general description of Exide Ironclad Batteries. Pp. 20.

Water Treatment. L. A. Salomon & Bro., 216 Pearl St., New York, N. Y. This booklet is of interest to those seeking data on taste and odor control in water purification. Pp. 50.

Graphic Instruments. Roller-Smith Co., Bethlehem, Pa. Catalog 830 describes graphic voltmeter for a.c. and d.c.; pp. 9. **Oil Circuit Breakers.** Catalog 6-e describes features of the "Turblator" oil circuit breaker; pp. 4.

Ash Handling System. Allen-Sherman-Hoff Co., 225 South 15th St., Philadelphia, Pa. Catalog 639Q illustrates and describes the Hydroget system that provides for the continuous storage of ashes for a long period and their periodic removal in a short time. Pp. 35.

Motor Pump. Ingersoll-Rand Co., Phillipsburg, N. J. Folder 1917 describes and illustrates a motor pump for general service in sizes delivery 5 to 1,000 g.p.m. and heads up to 500 ft; pp. 4. **Rock-Drill Catalog.** Form 4301 describes and illustrates the manufacturer's complete line of rock drills and associated equipment. A brief and interesting history of rock-drill development is also presented. Pp. 88.

Grinding Mills. Traylor Engineering & Mfg. Co., Allentown, Pa. Bulletin 2103 describes and illustrates the manufacturer's complete line of grinding mills. Pp. 29.

Pulling and Pushing Tools. Templeton, Kenly & Co., 1020 South Central Ave., Chicago, Ill. Bulletin P. & P. 40 illustrates uses of the manufacturer's Util-a-Tool unit for wheel pulling jobs and other uses. Pp. 4.

Hydromotor Jig. Southwestern Engineering Co., 4800 Santa Fe Ave., Los Angeles, Calif. Bulletin 1300 describes and illustrates features of a new jig for use in ore treatment. Pp. 4.

Welding Machine. Harnischfeger Corp., 4400 West National Ave., Milwaukee, Wis. Bulletin W-26 illustrates and describes the manufacturer's new 200-ampere multi-arc welding service.

Mining Equipment. Sundfelt Equipment Co., 3315 First Ave., South, Seattle, Wash. Bulletin 10 describes ball mills, jaw crushers, amalgamating equipment, and other mining and milling equipment. Pp. 4.

Rivet Heating Forges. Hauck Manufacturing Co., Brooklyn, N. Y. Bulletin No. 352 describes the oil and gasoline forges for rivet heating. Pp. 2.

Special Steels for Valves. Hadfields, Ltd. Bulletin 1356 describes features of special steels for internal-combustion engine valves; pp. 4. Bulletin 423 describes the manufacturer's stainless steel and iron products for industrial use; pp. 16. **Pulling Jack.** Bulletin 426 describes and illustrates the Hecla pulling jack; pp. 4.

Revolving Joints. Barco Mfg. Co., 1801-1805 Winnemac Ave., Chicago, Ill. Catalog 291 illustrates and describes revolving joints used to supply steam, gas, or other fluids from a fixed supply pipe to a rotating drum without leakage. Pp. 4.

Air Circuit Breaker. General Electric Co., Schenectady, N. Y. GEA-2997A describes air circuit breakers for protection of resistance welding machine up to 600 volts a.c.; pp. 8. **Arc Welder.** GEA-3081B describes a new 150-amp. size direct-current arc welder; pp. 4. **Differential Relays.** GEA-3253 illustrates and describes the manufacturer's Type LJD single- and triple-pole percentage differential relays; pp. 10. **Automatic Arc Welding.** GEA-3042A tells about the new thyratron-controller automatic arc welding process for use with bare or lightly coated electrodes; pp. 15.

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